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MALAYAN AGRICULTURAL JOURNAL

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DEPARTMENT OF AGRICULTURE, FEDERATION OF MALAYA.

Kuala Lumpur.

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THE

Malayan Agricultural Journal

JULY, 1951.

EDITORIAL

Blister Blight of Tea. In the January, 1949, issue of this Journal, the Senior Plant Pathologist, Mr. A. Thompson, gave an account of the arrival of Blister Blight disease in Southern India and Ceylon, warned of the damage the disease might do if it gained entry into Malaya and emphasised the importance of strictly enforcing the regulations controlling the importation of planting material.

Shortly after that article was written the disease was reported present in Sumatra and, inspite of the precautions taken to control the importation of plants and planting material, it attacked, some twelve months later, tea growing at Cameron Highlands. It is thought that the spores of the fungus *Exobasidium vexans,* the cause of the disease, were brought to Malaya from Sumatra by wind currents.

In this issue of the Journal, Mr. Thompson and Mr. Johnston, the Plant Pathologist, give an account of the arrival of Blister Blight of Tea in Malaya and of the investigations carried out so far into the incidence and control of the disease.

It is of interest to note that Blister Blight has been recorded on tea growing in the lowlands, but outbreaks are sporadic and damage is slight compared with that experienced at Cameron Highlands.

Increasing the Rice Crop. Investigations into the possibilities of increasing the yield of padi grown in Malaya are given priority by the Department of Agriculture. The task is a long and painstaking one involving many years work on the improvement of varieties and methods of cultivation of padi.

Two articles on later pages describe work being done to increase yields by the use of fertilisers and by improving padi variety characters.

The article on the improvement of rice yields by the use of fertilisers was originally written for the information of the Rural and Industrial Development Authority, its object being to place the subject in proper perspective in relation to other means of improving yields and the experience of other rice growing countries. While giving prominence to the more successful of recent experiments and the apparent opportunities that exist of appreciable gains in rice production, care was taken to warn

against over-optimism and to state the need for wider confirmation, for more investigation of quantity, type, and mode of fertiliser application, and, what is most important, for observation of long term effect. It was considered after the article had been written that it should be made available for general information.

A detailed account of the 1950-51 agronomic experiments on padi, with statistical appraisal, will be published, in conformity with normal practice, in a later issue.

The article dealing with the improvement of padi varieties gives information on the methods adopted by the Department, and a summary of the progress made with these methods.

Results of investigations into both methods of increasing yields offer encouragement but it is too early as yet to make specific recommendations in either direction.

BLISTER BLIGHT OF TEA IN MALAYA

1. Interim Report on Investigations 1950—1951

BY

ALDWORTH THOMPSON,

Senior Plant Pathologist,

and

ANTHONY JOHNSTON,

Plant Pathologist.

Introduction.

In January, 1949, a note on Blister Blight of the tea plant (*Camellia sinensis*) was published in this Journal (1), with the object of bringing to the notice of persons connected with the local tea industry the importance of this leaf and twig disease of highland tea which had not been recorded in Malaya but was causing concern in South India and Ceylon, where it appeared in 1946.

In April, 1949, the disease was reported from Sumatra, on highland tea, and, despite the institution of rigorous "quarantine" regulations designed to control the importation of plants and planting material of all plants from the infected territories, the disease appeared in Malaya in February, 1950. It is thought that the spores of the fungus *Exobasidium vexans* were carried to Malaya from Sumatra by wind currents and were deposited or brought down by rain from high altitudes.

When first discovered in Malaya, on highland tea at Cameron Highlands, the disease was confined to one area, there being six outbreaks in two distinct groups about one mile apart. Attempts to eradicate the fungus were unsuccessful, mainly due to centres of infection arising in areas of tea, growing on the boundaries under semi-jungle conditions, awaiting reclamation. It has been the experience in other countries that Blister Blight could not be eradicated once it had appeared and it was soon obvious at Cameron Highlands that eradication would be impossible. In two months the disease had extended to other areas in the highlands and by the middle of the year was present on all estates and holdings in the district. In May, 1950, it was recorded on an estate in the lowlands, and in the early part of 1951 appeared on other lowland properties. In the lowlands, sporadic outbreaks occur in damp, shaded areas but the damage done is slight in comparison with damage on highland properties. It is of interest, however, to record that the disease can occasionally operate in tea grown almost at sea level.

Field Observations.

On the estate where the disease first appeared, the main planted area is roughly basin shaped, with a break on the eastern side which allows the early morning sun (7 a.m.) to shine on most of the fields facing east, and from 11 a.m., in fine weather, most of the fields are in full sunshine at least for a few hours. The land is steeply sloped on the north and

south boundaries, which rise to 5,500 ft, and, from a ridge to the west, slopes more gradually to the east down to a flatter area at about 3,500 ft. elevation. Cloud mist tends to cover the high ground from late evening to early morning and lingers there rather than in the valley areas. The disease was more severe in this mist belt and in fields shaded from morning sun or in which shade trees—mostly *Grevillea* sp.—were growing closely. Under these conditions blisters were numerous, tended to become confluent and to develop on the young, green twigs.

There is evidence that exposure to sunlight not only kills the spores which have become attached to a leaf, but the development of blisters may be checked if the fungus mycelium has not penetrated deeply into the leaf. Moisture, high humidity and shade are the principal factors which favour the development of the fungus in the field. Millions of spores are produced on the blisters, but only a comparatively small number of these find conditions suitable for germination and penetration of the cuticle of the young tea leaves to an extent which permits the formation of blisters and the production of further spores thus completing the life history. It has been found at Cameron Highlands that spore germination and leaf penetration do not occur unless there is a film of moisture present on the young leaf over a period exceeding eight hours. Thus, when humidity is high during the night, say from 7 p.m. to 6 a.m., infection is more likely to occur than in the daytime. It is possible that spores which do not germinate before 3 a.m. will not infect a leaf if the latter is dried by the morning sun, but if the early morning is misty and sunshine is obscured, spores may infect so long as damp, cloudy conditions prevail. Preliminary artificial inoculations carried out at Cameron Highlands have shown that 12 days can elapse between infection and the production of spores on the blisters which develop following successful leaf infection. Spore production may continue for 20 days in the laboratory, but in the field the blisters have not been observed to sporulate for longer that seven to eight days, and this period is often shorter due to blackening of the blisters when they are invaded by other fungi, e.g. the brown blight fungus *Colletotrichum camelliae* (*Glomerella cingulata*). Other fungi, such as *Cladosporium* sp., *Pestalotia* sp. (not *P. theae*) and *Phyllosticta* sp., also develop in the tissue of the blistered area of a leaf but the principal secondary fungus is usually *Colletotrichum*. Further studies are needed, however, before it can be accepted that the partial biological control exercised by Colletotrichum on *E. vexans* is entirely beneficial. Colletotrichum is a fungus which also can damage tea leaves to a certain extent, e.g. following sun scorch after "tipping", and damage might be accentuated if bushes weakened by Blister Blight are rendered more susceptible to the effects of Brown Blight acting in conjunction with Blister Blight. Spores of Colletotrichum appear to be present on practically every blistered leaf, and in many instances observed at Cameron Highlands the Brown Blight fungus growing on blistered tissue had extended into the healthy part of the leaf outside the blisters and considerably increased the area of leaf tissue damaged by the original blister.

Table I.

Rainfall at Cameron Highlands, 1934 to 1940.

(in ins.)

Year.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
1934	5.6	6.4	13.7	13.7	11.6	9.2	4.0	7.8	10.3	14.5	14.2	6.1
1935	7.4	3.6	6.8	11.4	9.5	9.2	3.8	12.5	7.2	15.9	15.4	10.8
1936	9.3	5.5	5.5	16.6	12.6	4.8	2.6	7.4	9.4	9.1	10.7	10.8
1937	3.7	5.8	6.0	9.9	7.4	3.2	1.7	4.0	11.2	14.4	12.1	7.0
1938	2.5	6.2	10.3	11.3	6.4	3.1	4.7	7.8	8.4	11.2	7.6	9.0
1939	7.7	5.0	14.0	8.5	8.0	7.9	2.7	3.7	16.1	13.7	12.3	3.1
1940	4.7	3.2	4.3	7.0	9.3	7.6	3.3	3.2	10.5	17.5	20.7	10.5
Total for 7 years	40.9	35.7	60.6	78.4	64.8	45.0	22.8	46.4	73.1	96.3	93.0	57.3
Range	2.5 to 9.3	3.2 to 6.4	4.3 to 13.7	7.0 to 16.6	6.4 to 12.6	3.1 to 9.2	1.7 to 4.7	3.2 to 12.5	7.2 to 16.1	9.1 to 17.5	7.6 to 20.7	3.1 to 10.8
Mean over 7 years	5.8	5.1	8.6	11.2	9.2	6.4	3.2	6.6	10.4	13.7	13.3	8.2

Infection of the young, open leaf most frequently follows spore deposition on the upper surface of the leaf, probably because spores fall more often on this surface than on the under surface and are retained long enough to adhere. A film of moisture can be retained on the surface of young leaves with incurved edges for a period sufficient for spore germination and cuticle penetration, and it is in this stage that infection is most likely to occur.

Infection of buds has also been demonstrated at Cameron Highlands; e.g. blisters 3.5 mm. in diameter were present on leaves which had just unfolded from buds inoculated eight days previously, and, in one series of inoculations, spores developed 14 days after inoculation on buds which had not unfolded. In the field, the pin-point stage of infection has been noticed on leaves just beginning to unfold and these leaves must have been infected in the bud.

At Cameron Highlands, blisters are not very numerous on the bushes reserved for seed production, or on the bushes which have grown tall in the unreclaimed areas. These bushes are growing under more normal conditions than the bushes in plucking, i.e. they are not pruned periodically and the young leaves are not plucked at frequent intervals, so that there is not a constant production of young, susceptible foliage and there is often no large reservoir of infection in the immediate vicinity of the young leaves when they are formed from time to time.

Climatic Conditions at Cameron Highlands.

In normal years, the rainfall is heaviest between October and the end of the following January. During these months there is less morning sun, more persistent mist and somewhat higher humidity than in the period from February to September. Showery weather is usual in the months from March to June when the temperature increases slightly. July and August are usually fairly dry with lower humidity than is experienced in the other months. In some years, however, there can be a departure from the normal, and total rainfall recorded in the middle of the year may be as heavy as in the March to June period, or the latter period may be drier than usual. It is most unusual to experience dry weather, for any length of time, in the period October to January. The accompanying Tables have been compiled from records taken at Cameron Highlands recently and in the past.

Incidence of the Disease.

It was anticipated (1) from a study of the meteorological records that climatic conditions at Cameron Highlands were likely to favour the Blister Blight fungus in the first and last quarters of the year, and that the incidence of the disease would be highest in these periods and at its lowest in the July to September period. Estates were advised to arrange for pruning to be done so that the bushes would refoliate during the drier months, thus lessening the risk of attack by the fungus on the highly susceptible, new growth.

In order to obtain definite information as to the variation in incidence of the disease in the different periods of the year, a junior officer was stationed on a large tea estate at Cameron Highlands from time to time. The plucked leaf from the various fields, brought daily to the factory for manufacture, was sampled, and 100 shoots were taken at random from the bags of leaf from each field. These samples were examined and divided into four grades, i.e. healthy, and light, medium and heavy infection, the results being recorded as percentages of the total. Thermometers—maximum and minimum, and wet and dry bulb—were placed within the bushes at two sites on the estate, one site being in the mist belt, and records were taken in the early morning and the afternoon. These recordings began in April, 1950, and continued until June, 1951. The results are given in the accompanying tables. In Table III, temperature and humidity records taken on the estate and at Tanah Rata have been grouped and averaged, and total rainfall and mean hours of sunshine are shown. Graph I shows the incidence of Blister Blight and the influence on the disease of sunshine, humidity, rainfall and temperature experienced in this highland district from April, 1950, to June, 1951. The records of incidence are given in Table IV.

These records are of total infection and it should be explained that during the period April to September the records showed that the degree of infection was generally light, with only a few records of a medium degree of infection, whereas, in the period October to January, records of medium infection were numerous and some heavy infection was also present, especially in December. These remarks also apply to the records of incidence in bushes recovering from pruning shown in Table V and Graph II.

The marked influence of climate on the incidence of Blister Blight may be seen from the records shown in the Tables and Graphs. In wet periods, humidity is high and sunshine is obscured. During such periods infection begins to build up and reaches its maximum some weeks after the commencement of the wet weather.

The records show that infection had reached a peak in April and May, 1950, but began to decline in June, when rainfall was lessening, and was negligible in July and August, during which months the longer, drier periods, lower humidity and increased sunshine exerted a marked effect. There was no build up of infection until, with increasing rainfall, higher humidity, reduced sunshine and lower temperature in October and November, the maximum of infection was reached in December, although in that month a temporary improvement in the weather appears to have been responsible for a temporary check to the disease in January, 1951. The disease was again favoured by climatic conditions in January and infection increased to the degree experienced in the beginning of 1950. There was again a temporary improvement in April, following drier conditions in March, despite the increased flush of young leaf which, as is usual, was plentiful at this period. (Yields of highland tea, locally, are, on the average, lower in the November to January period, higher in March and April, and may drop slightly in the dry months of July and August).

Table II.

Mean Shade Temperature and Mean Sunshine at Cameron Highlands, 1934 to 1940.

Year.	Jan.		Feb.		March		April		May		June		July		August		Sept.		Oct.		Nov.		Dec.	
	°F	Sun hrs. per day.	°F	Sun hrs. per day.	°F	Sun hrs. per day.	°F	Sun hrs. per day.	°F	Sun hrs. per day.	°F	Sun hrs. per day.	°F	Sun hrs. per day.	°F	Sun hrs. per day.	°F	Sun hrs. per day.	°F	Sun hrs. per day.	°F	Sun hrs. per day.	°F	Sun hrs. per day.
1934	63.3	4.13	62.7	3.78	63.7	3.33	64.3	3.66	64.4	5.71	65.1	4.47	64.1	4.20	64.3	4.55	64.1	4.08	64.7	3.36	63.9	3.28	62.7	4.48
1935	63.1	5.51	63.1	6.77	65.3	4.82	65.1	4.22	65.5	4.29	64.8	4.94	64.1	4.39	64.0	4.00	64.0	4.47	65.5	2.60	64.9	3.39	64.3	3.79
1936	64.3	2.87	64.3	6.47	64.7	5.19	66.5	5.60	65.9	4.65	63.6	6.39	64.3	5.44	64.5	4.90	64.6	3.90	64.6	3.73	64.7	3.80	64.3	3.73
1937	63.1	4.87	63.7	6.27	65.5	4.97	66.8	4.30	65.9	4.72	65.8	4.63	64.2	5.10	63.7	5.20	65.0	4.13	64.3	3.37	64.7	3.39	63.9	2.67
1938	63.8	5.90	63.7	6.23	64.8	4.13	66.3	4.96	66.2	4.10	63.9	5.96	63.8	5.58	63.9	3.66	64.2	3.86	63.9	4.24	63.8	4.43	61.9	4.12
1939	63.3	3.15	62.7	5.04	63.1	5.08	65.7	4.75	65.5	4.92	64.9	5.17	63.3	6.23	64.3	4.87	64.3	2.67	64.7	3.54	64.9	3.94	63.9	3.66
1940	62.3	5.18	62.2	5.51	62.9	5.65	65.3	5.73	66.5	4.05	65.6	4.95	63.9	5.46	64.9	4.39	64.5	3.51	64.9	4.41	63.5	2.88	63.8	4.65
Total	443.2	31.61	442.4	40.07	450.0	33.17	460.0	33.22	459.9	32.44	453.7	36.51	447.7	36.40	449.6	31.57	450.7	26.62	452.6	25.25	450.4	25.11	444.8	27.10
Range	62.3 to 64.3	2.87 to 5.9	62.2 to 64.3	3.78 to 6.77	62.9 to 65.5	3.33 to 5.65	64.3 to 66.8	3.66 to 5.73	64.4 to 66.5	4.05 to 5.71	63.6 to 65.8	4.47 to 6.39	63.3 to 64.3	4.20 to 6.23	63.7 to 64.9	3.66 to 5.20	64.0 to 65.0	2.67 to 4.47	63.9 to 65.5	2.60 to 4.41	63.5 to 64.9	2.88 to 4.43	61.9 to 64.3	2.67 to 4.48
Mean over 7 yrs.	63.3	4.51	63.2	5.72	64.3	4.74	65.7	4.74	65.7	4.63	64.8	5.21	63.9	5.20	64.2	4.51	64.4	3.80	64.6	3.60	64.3	3.58	63.5	3.87

PLATE I.

Tea bush pruned in August, 1950: sprayed at weekly intervals until February, 1951: photographed March, 1951.

Tea bush pruned in August, 1950: not sprayed: photographed March, 1951.

PLATE II.

Tea bush pruned in September, 1950: sprayed at weekly intervals until March, 1951: photographed March, 1951.

Tea bush pruned in September, 1950: not sprayed: photographed March, 1951.

If, through shortage of labour or for other reasons, the plucking interval is lengthened there will be increased spore production and it is probable that, with much susceptible leaf available, the disease will tend to increase in the months of heavy flushing, particularly if morning cloud mists do not disperse early and persist in certain areas even though total rainfall may be low and sunny periods frequent.

From the results obtained and observations made on the estate and at Tanah Rata Experiment Station, where the incidence of the disease was also under study, it has been found that the disease followed the expected course, i.e. that incidence would be high in the first and last months of the year and low during the period from June to the end of September. It may be concluded that in years of normal rainfall, it would be beneficial, from the disease control aspect, if pruning were done in May and June rather than at other periods. Reports from Ceylon, and evidence obtained at Tanah Rata, however, indicate that good protection of pruned areas can be obtained by spraying, even in the wetter months, and it is possible that further study will show that pruning can be undertaken locally at any convenient period, and that for quick recovery it might not be a disadvantage if bushes were pruned earlier or later than May or June. There is likely to be increased damage from branch canker and Brown Blight in pruned areas where shade has been removed or reduced in order to check Blister Blight, and it is probable that this damage would be more severe in the drier and sunnier months.

Incidence of Blister Blight on Pruned Bushes.

In June, 1950, observations on pruned bushes were begun. In that month, a plot, one acre in area, was close pruned and divided into four sub-plots of ¼ acre each. One sub-plot was sprayed (Perenox, 4 ounces in 10 gallons water) every seven days until brought into plucking, another sub-plot was similarly sprayed, and manured (in advance of pruning) with a 1:1:2, N.P.K. artificial fertiliser: one sub-plot was manured but not sprayed and one sub-plot was given no treatment. Each month, up to May, 1951, further plots were also pruned and treated similarly. Records were taken each month of the percentage of these bushes affected by Blister Blight during the refoliation period, and the degree of infection and the general condition of the bushes were noted.

The results are given in Table V and Graph II

There is no evidence of benefit from the manurial dressing, but the protection conferred by spraying is well marked. Plates I, II and III show the difference, five to six months after pruning, in the appearance of sprayed and unsprayed bushes pruned in August and in September, 1950. It is of interest to record, however, that unsprayed bushes made a good recovery in the period March to June, 1951, when, although incidence was high, the degree of infection was generally mild, and by July 1951 there was little difference in the general appearance of the sprayed and unsprayed bushes in the plots pruned in June, July, August,

Table III.

Temperature and Humidity as Recorded near Tea Bushes, and Rainfall and Sunshine at Cameron Highlands, 1950-51.

Field 13.	April, 1950.				May, 1950.				June, 1950.				July, 1950.			
	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.
Range	78-88	58-63	90-100	67-95	78-90	58-60	95-100	70-100	70-86	53-64	87-99	59-95	72-84	52-60	94-100	70-100
Mean	86.0	59.0	95.6	86.0	84.8	59.0	97.0	90.0	84.9	58.2	97.1	74.4	75.3	54.6	97.3	85.2
Mean of R.H. and mean max. temp. from four different fields	90.3 per cent. 86 °F (one field)				90.3 per cent. 85 °F (one field)				84 per cent. 85 °F (one field)				86.2 per cent. 86 °F			
Total Rainfall	6 ins.				10 ins.				3.7 ins.				7.8 ins.			
Mean Sunshine	4.8 hrs.				4.6 hrs.				5.2 hrs.				5.2 hrs.			

Field 13.	August, 1950.				September, 1950.				October, 1950.				November, 1950.			
	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.
Range	72-94	52-62	94-100	65-100	68-82	54-62	94-100	59-100	70-88	56-60	89-100	63-100	66-82	56-60	94-100	81-100
Mean	81.6	57.4	98.2	85.0	77.0	59.2	97.0	81.3	78.5	57.8	98.4	87.0	75.6	57.5	98.0	93.6
Mean of R.H. and mean max. temp. from four different fields	89.7 per cent. 86 °F				90 per cent. 79 °F				92.5 per cent. 80 °F				95.7 per cent. 76 °F			
Total Rainfall	8.7 ins.				9.2 ins.				9.8 ins.				14.0 ins.			
Mean Sunshine	5.2 hrs.				4.4 hrs.				4.0 hrs.				2.7 hrs.			

Table III—(*cont.*)

Field 13.	December, 1950.				January, 1951.				February, 1951.				March, 1951.			
	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.
Range	62-84	54-60	80-100	56-100	64-82	50-60	79-100	73-100	64-86	54-60	94-100	69-100	78-90	50-62	77-100	61-100
Mean	75.6	57.4	95.2	84.7	74.9	57.2	95.8	88.5	75.7	56.0	99.7	93.1	83.9	56.5	95.4	82.6
Mean of R.H. and mean max. temp. from four different fields	88.4 per cent. 77 °F				91.7 per cent. 76 °F				95.5 per cent. 77 °F				88 per cent. 89 °F			
Total Rainfall	5 ins.				13.3 ins.				9.2 ins.				3.4 ins.			
Mean Sunshine	2.9 hrs.				2.5 hrs.				3.6 hrs.				4.8 hrs.			

Field 13.	April, 1951.				May, 1951.				June, 1951.			
	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.	°F Max.	°F Min.	R.H. 8 a.m.	R.H. 3 p.m.
Range	70-84	50-62	94-100	64-100	70-84	50-62	94-100	74-100	74-84	48-62	84-100	65-100
Mean	76.7	56.9	96.0	89.0	76.7	56.9	96.5	90.8	77.2	55.6	95.6	81.4
Mean of R.H. and mean max. temp. from four different fields	92.5 per cent. 87 °F				93.3 per cent. 77 °F				87.6 per cent. 78 °F			
Total Rainfall	10.7 ins.				6.8 ins.				3.4 ins.			
Mean Sunshine	5.3 hrs.				3.7 hrs.				3.5 hrs.			

November and December, 1950, and in January, 1951. (Plates IV and V). In the plots pruned in September and October, 1950, spraying gave excellent protection prior to tipping and damage was slight on sprayed bushes, whereas there were many dead branches and a very poor canopy of leaves on the unsprayed bushes. The latter, however, began to improve in appearance from the end of May to July, 1951.

The experiment has shown that spraying with a copper fungicide confers excellent protection and there is an indication that, if general weather conditions are less favourable to the fungus, in any period of the year, pruning can safely be undertaken, except perhaps in September and October. It would appear that it might be found possible either to dispense with spraying in the drier periods or to lengthen the interval between spray applications without serious risk, so long as weather conditions do not favour a build up of infection, but in places especially liable to attack, i.e. under heavy shade or near jungle, spraying should be undertaken even in periods of low rainfall.

Future Programme of Investigations,

Records of the incidence of the disease will be continued and further experiments are now in progress with the object of investigating the efficacy of different fungicides; the effect of different rates of application, different strengths of solution and period of time between applications. The experiment on the effect of spraying pruned bushes will be continued, and it is hoped to obtain information as to loss of crop (if any) in unsprayed fields, and to determine costs of spraying. (It is known already that, under present conditions in Malaya, such costs are appreciably higher than in Ceylon and it is desirable to investigate the possibility of reducing costs).

Mechanical spraying equipment will probably be available later in the year, and, if the staff position permits, this equipment will be used in experiments, on the effect of thorough and surface spraying of bushes in plucking, in which comparative costs and benefits (if any) will be ascertained.

Control of Blister Blight, as assisted by the more indirect methods, will also be investigated in so far as staff resources are available. These investigations will include continuation of the time of pruning experiment and manuring as mentioned above, and further experiments on type of pruning (normal versus light) and effect of weeds. The matter of investigating the possibility of establishing resistant clonal material has received attention at Tanah Rata, and, during the October, 1951 to January, 1952 period, when the disease should be prevalent, it is intended to make selections from bushes showing resistance.

It is also proposed to attempt, by using spore traps, to determine the number of spores of *E. vexans* present in the air at different times of the year and under different atmospheric conditions with a view to obtaining information on spore disposal and reasons for fluctuations in infection.

PLATE III.

Plot pruned in September, 1950: sprayed at weekly intervals until March, 1951: photographed March, 1951.

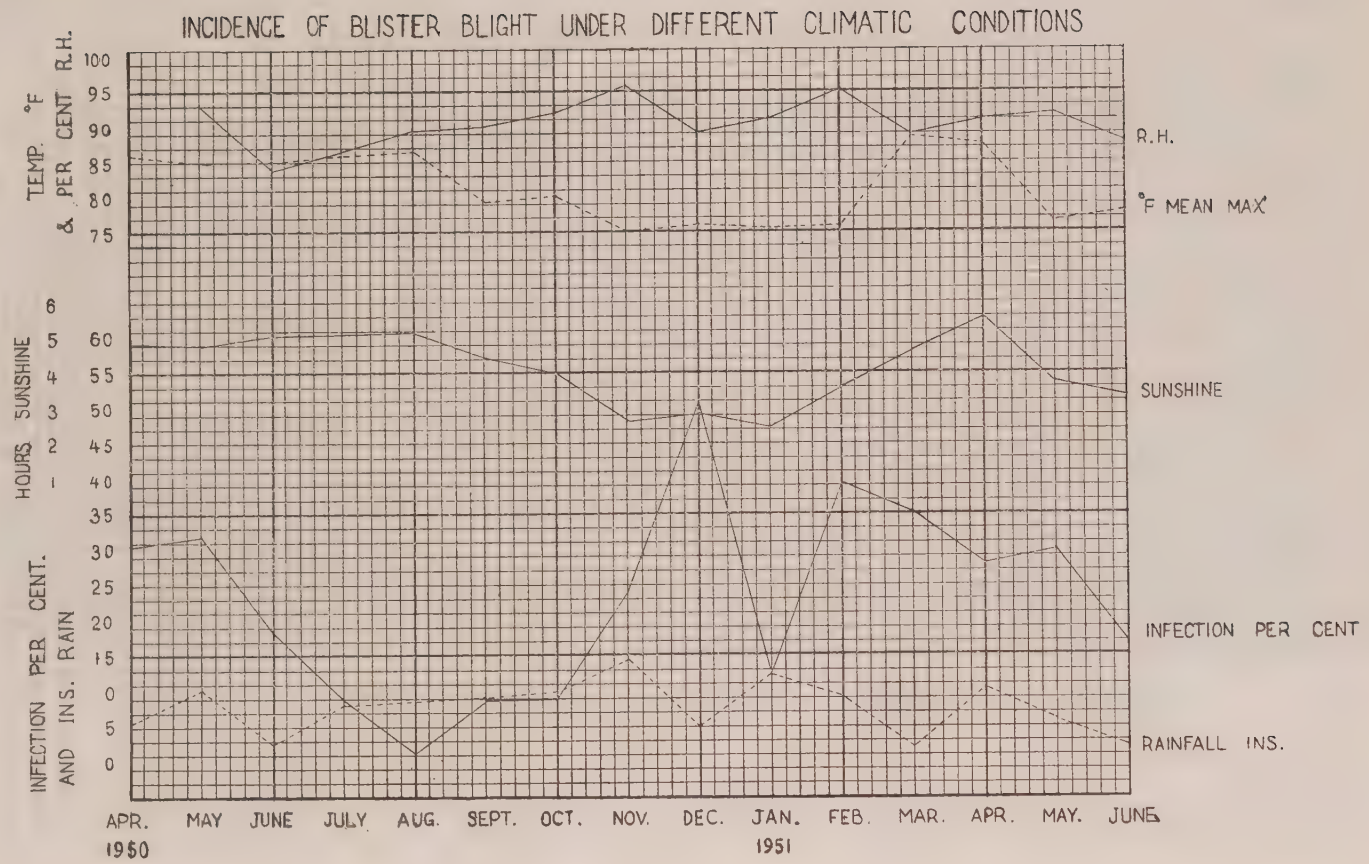
Plot pruned in September, 1950: not sprayed: photographed March, 1951.

PLATE IV.

Tea bush pruned August, 1950: sprayed until February 1951: photographed August, 1951.

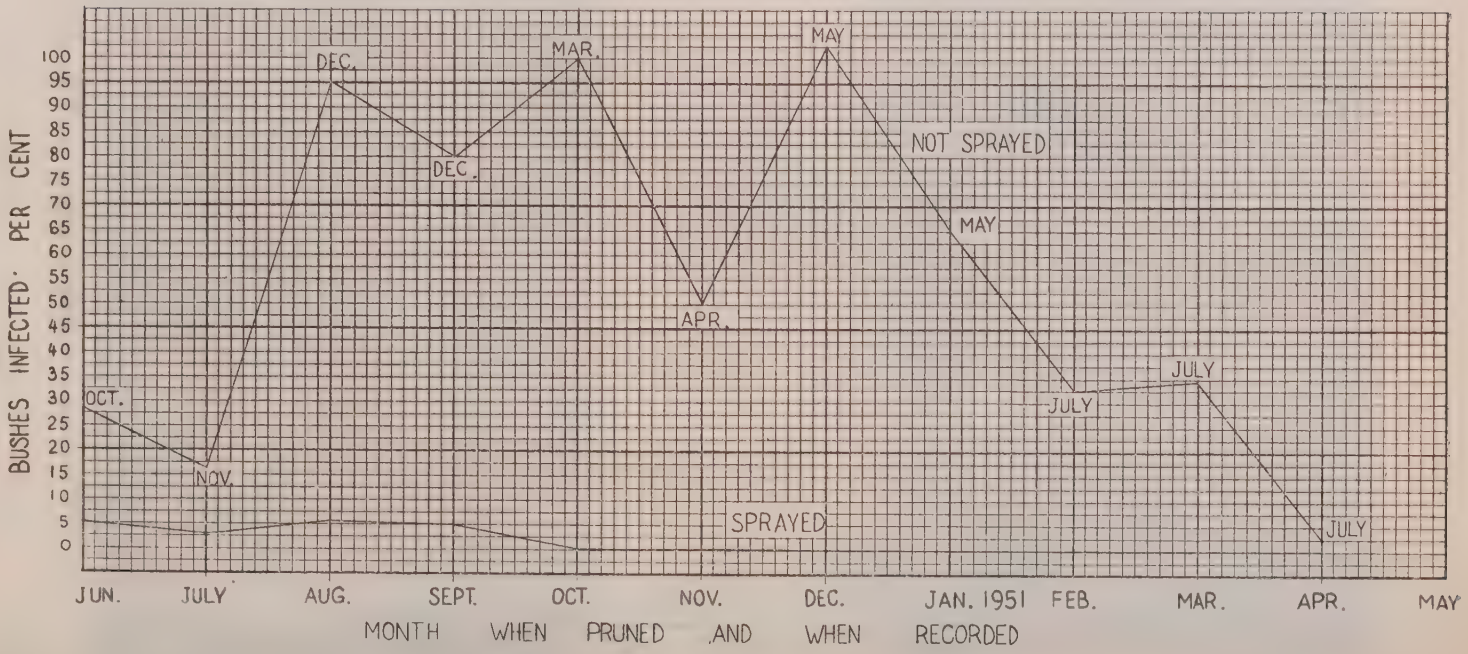
Tea bush pruned August, 1950: not sprayed: photographed August, 1951.

GRAPH I


INCIDENCE OF BLISTER BLIGHT UNDER DIFFERENT CLIMATIC CONDITIONS
TEMP. °F & PER CENT R.H.
100
95
90
85
80
75
HOURS SUNSHINE
6
5
4
3
2
1
60
55
50
45
40
35
INFECTION PER CENT. AND INS. RAIN
30
25
20
15
0
5
0
R.H.
°F MEAN MAX
SUNSHINE
INFECTION PER CENT
RAINFALL INS.
APR. 1950
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
JAN. 1951
FEB.
MAR.
APR.
MAY.
JUNE

GRAPH II.

INCIDENCE OF BLISTER BLIGHT ON PRUNED BUSHES & EFFECT OF SPRAYING



The question of copper content of sprayed leaves is also under investigation, and preliminary records show that, in comparison with the normal copper content of unsprayed leaves locally—16 to 18 p.p.m. * based on dry weight—a content of between 81 to 200 p.p.m. may be present in leaf sprayed with copper fungicides.

These figures were obtained during a period of fairly dry weather when spraying of tea in plucking probably would not be carried out. At present, spraying of tea in plucking is not practised and has not been advised. During wetter weather, when such spraying might be justified, the copper content of the leaves is likely to be less, as some of the fungicide would be washed off. The copper content of tea is of importance in that tea with more than a given amount of copper (at present 150 p.p.m. in manufactured tea) cannot be marketed in Great Britain.

Discussion.

One important method of controlling the fungus is the removal of leaf, in the plucking rounds, before the blisters have sporulated. From reports published in Ceylon and Indonesia, and from preliminary studies in Malaya, it would appear that there might be quite a difference in the time taken by the fungus to complete its life cycle in the three countries. This apparent difference, however, may not be real unless of course there are different strains of the fungus in the different countries. If studies on the life cycle of *E. vexans* were continued throughout the year, under different conditions and on different ages and types of leaf, it is possible that the average time would be similar, and that the life cycle would be found to extend from 10 to about 21 days. It is reported from Ceylon (2), (3), that the life cycle of *E. vexans,* from infection of a leaf to production of spores on the blister, extends from 14 to 21 days (average 18 days), and that the germ tube of a spore can penetrate into a leaf in eight hours. Leaves up to 30 days old can be infected, and the translucent spots first appear within six to ten days following successful infection. (A "ripe" blister may therefore appear on a leaf which is 30 plus 18 days old and give the false impression that the fungus can attack leaves older than 30 days).

In Sumatra, the fungus is reported to complete its life cycle in 10 days. The preliminary artificial inoculations mentioned above, carried out at Cameron Highlands, have shown that 12 days may elapse between infection and sporulation. It is unlikely that the fungus will be found capable of sporulating earlier than 10 days after infection, unless new strains of *E. vexans* should arise by mutation; for practical purposes, it can be accepted, at present, that a plucking interval which is less than 12 days would normally be sufficient, in Malaya, to achieve benefit by this method of control.

The principal plant disease fungi, other than root fungi, present in Malaya have not, in general, had such severe effects on crops as in other countries in this region where monsoon rains are more continuous and

* Parts per million.

Table IV.

Incidence of Blister Blight on Tea in Plucking at Cameron Highlands, 1950-1951.
(Infection per cent.)

	1950									1951					
	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June *
Range	6-64	4-76	1-38	1-22	1-13	6-12	1-36	4-57	34-77	10-20	9-62	9-73	9-47	11-48	2-30
Mean	31	33	18	9	2	9	9	24	51	13	39	35	27	30	17

* 1st half of month.

Table V.

Incidence of Blister Blight in Areas Pruned in Different Months.
Records taken 3 to 5 Months after Pruning in Sprayed, Manured and Unsprayed Plots

Treatment	Pruned June, 1950	Pruned July, 1950	Pruned Aug., 1950	Pruned Sept., 1950	Pruned Oct., 1950	Pruned Nov., 1950	Pruned Dec., 1950	Pruned Jan., 1951	Pruned Feb., 1951	Pruned March, 1951	Pruned April, 1951
A	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Manured and sprayed	8.0	4.0	12.0	3.0	0	0	0	0	0	4.0	0
B											
Sprayed	5.0	2.0	5.0	4.0	0	0	0	0	0	0	0
C											
No treatment	27.0	15.0	94.0	78.0	100.0	50.0	100.0	66.0	34.0	35.0	0
D											
Manured not sprayed	41.0	36.0	82.0	96.0	98.0	58.0	88.0	68.0	66.0	44.0	0
Records as taken in	Oct., 1950	Nov., 1950	Dec., 1950	Dec., 1950	Mar., 1951	April, 1951	May, 1951	May, 1951	July, 1951	2nd July, 1951	26th July, 1951

PLATE V.

Plot pruned in September, 1950: sprayed at weekly intervals until February, 1951: photographed August, 1951. c.f. Plate III.

Plot pruned in September, 1950: not sprayed: photographed August, 1951. c.f. Plate III.

dry periods occur more regularly. For example, the fungus *Phytophthora palmivora* does not do much damage to rubber in Malaya, where secondary leaf fall of Hevea, due to this fungus, is not known to occur, neither has coconut bud-rot (Phytophthora) been recorded. In Ceylon, however, this fungus is the cause of much damage to rubber and coconuts in the monsoon periods. The fungus *Oidium heveae* is more serious in Ceylon than in Malaya and occurs during the dry period in Ceylon between the N.E. and S.W. monsoon. Although there is not a *regular* and well marked dry period in the highland tea areas in Malaya, the weather conditions in the S. W. monsoon (May to September) are less favourable to the fungus, because humidity is low and sunny mornings and, frequently, sunny days are more usual than in those tea growing countries where the sun may not be seen for days and rain is often continuous. Even in the N.E. monsoon, from November to February, when the weather can be unpleasant, continuous rain without a sunny break is not common, and does not normally last for more than 48 hours at a stretch.

It is hoped that, even though Blister Blight may be present locally on highland tea all the year round, the Malayan climate may not prove to be as favourable to the fungus as the climate in the "monsoon" countries and that the serious damage reported in highland tea grown in those countries may not be experienced to the same extent in Malaya. The records obtained from the experiments now in progress and to be conducted during the next three years should show the course likely to be taken by the disease in this country, and should provide adequate information on which control measures suited to local conditions can be based.

The planted area under highland tea, all at Cameron Highlands, is approximately 6,000 acres, and there is approximately 3,000 acres planted in the lowlands. It is probable that, in view of the occurrence of Blister Blight in highland areas, further expansion of the acreage under tea will be in the lowlands, where the disease is of little importance, at least until such time as it is known whether new areas in the highlands can safely be planted with material which has proved to be resistant to the disease.

Summary.

An account is given of the first occurrence of Blister Blight of tea in Malaya in February, 1950, and of the investigations conducted to-date into the incidence and control of the disease.

The influence of the local climate, and the "microclimate" in the vicinity of the bushes, on Blister Blight incidence is shown in Tables and Graphs prepared from records taken on a highland estate and at the Agricultural Station, Tanah Rata, Cameron Highlands.

The excellent protection given, to bushes recovering from pruning, by spraying with a copper fungicide is also described and illustrated by photographs.

The question of suitable months in which to prune bushes, so as to avoid the worst effects of the disease, is discussed, and it is considered that pruning can be undertaken without serious risk at any period, except,

perhaps, between September and November, especially if spraying is undertaken when wet weather sets in.

A programme of further investigations into the disease and study of the causal fungus, *Exobasidium vexans*, is briefly described, and, if these investigations can be continued over the next three years it is hoped that sufficient information will be obtained to permit of definite conclusions as to the course the disease is likely to take and as to the control measures most suited to local conditions.

It is thought that, in the near future, further extension of the acreage under tea in Malaya is likely to be in lowland areas, where the disease occasionally appears but does comparatively little damage, at least until supplies of planting material, known to be resistant to Blister Blight, become available.

Acknowledgements.

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IMPROVEMENT OF RICE YIELDS IN MALAYA BY THE USE OF FERTILISERS

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The estimated wet padi crop of Malaya in 1950 was 266,994,000 gantangs, and, having been grown on an estimated area of 871,470 acres, represents an average yield of 306 gantangs per acre. The average yield fluctuates from year to year, although it has tended to increase over a period of years.

The fluctuations are very largely due to the weather, for perfect conditions rarely occur and then not everywhere, but social and economic conditions affecting the padi planters also have their effect.

A powerful influence to reduce annual fluctuation and to raise the general average yield is controlled irrigation and drainage; the former of these factors working to avoid the loss caused by drought and delayed planting, and the latter working to avoid or reduce damage caused by floods and to improve the fertility of the soil. Another influence tending to raise the average yield is the use of higher yielding strains of rice, and a possible third influence in that direction is the application of fertilisers. (There are other possible influences which need not be considered here).

When the average yield of padi in Malaya is compared with that of other producing countries, the position is not altogether unsatisfactory, as the following figures show—

Malaya	1,600 lbs.	per acre.
India	1,200 „	„ „
Burma	1,500 „	„ „
Thailand	1,650 „	„ „
Indo-China	1,300 „	„ „
Philippines	1,400 „	„ „
Ceylon	1,000 „	„ „
Indonesia (Java)	1,650 „	„ „
China	2,500 „	„ „
Australia	3,000 „	„ „
Italy	3,500 „	„ „
Spain	3,600 „	„ „
United States of America	2,500 „	„ „
Japan	3,100 „	„ „

The rice plant is strongly influenced by length of day, and regions close to the equator where diurnal variation is very small do not appear to be adapted for its most favourable growth.

The above mentioned countries which lie in sub-tropical and temperate regions depend to a great extent on manuring for the maintenance of high yields, and, except in the case of Japan, rice is not grown every year on the same land but in rotation with other crops.

In Malaya, and in other tropical countries, it is the common practice to grow rice year by year on the same land without manuring, and in the off-season some other crop may be grown or the land may be left fallow. Where *sawah* * rice is grown on alluvial or otherwise fertile soil it has the capacity, if irrigated, to produce a sure crop every year indefinitely, unlike other cereals on dry land. It appears to receive, in its aquatic conditions of growth, sufficient supplies of essential nutrients. The effect of using fertilisers on irrigated rice is much less predictable than with most agricultural crops, and the whole question of how the rice plant obtains its requirements and what is the availability of natural or added nutrients in the *sawah*, is a matter not yet clearly understood.

Nevertheless, there is wide experience in tropical countries that fertilisers can raise yields of rice, for all countries have made trials to see whether their rice crop benefits from fertilisers even though it may have been grown for centuries without their use. But it is important to note that there is no fertiliser which will benefit everybody who grows rice. It was soon found that in some territories nitrogen was beneficial but not so phosphorus, in other territories it was the reverse. Potash though seldom beneficial was very markedly so in some places. In India, as a whole, vast though the area is, it seems that nitrogen is generally beneficial. In Java, phosphate is the effective fertiliser, but different types are best adapted to different areas. In Indo-China, soils are very variable and fertilisers have to be varied accordingly. The proportion of the rice crop of tropical Asia which receives fertiliser applications is still very small and much more information is required, but it is possible to move forward with confidence in widely extending the practice.

Malaya stands out as an exception to surrounding countries in its comparative failure to find benefit from application of fertilisers to padi. Before discussing the results of trials made in Malaya, it should be pointed out that there is no overruling factor which so limits padi production that high yields cannot be obtained. When it is stated that the average yield is 300 gantangs per acre, it must be remembered that this figure is inclusive of much poor land, crops damaged by drought, flood, pests, diseases, and land not well farmed. Very large areas yield over 400 gantangs per acre normally, and there are limited areas which yield 800 and even 1,000 gantangs per acre. Research officers have not failed to study the soils of these exceptionally high yielding places in comparison with the other padi soils in order to search for what one soil has got that the other has not. There has been no satisfying outcome of this search yet, and it still continues.

Field experiments, consisting of the application of definite amounts of fertiliser in a systematic manner to a set of plots, and weighing the

* An irrigated padi field.

respective yields after harvest, have been conducted in the western states of Malaya since 1918. Even in 1912 there were some experiments in Krian, Perak, but the results are not on record.

It was an early experience that sulphate of ammonia depressed yields, and potash behaved similarly. Various forms of phosphate were beneficial, and combinations of phosphate and nitrogen also. By 1931, it had come to be considered that there is a limit to the yield of padi which can be produced at a given locality in a particular year, and that fertilisers cannot raise the crop beyond this. In most parts, the increase obtainable was not economic in relation to the cost of fertiliser. Experiments were nevertheless continued right up to the war with organic and inorganic fertilisers, as well as green manure, yet still without attaining any consistent success.

In 1932, fertiliser experiments began to be conducted in Kelantan on some of the poorer soils and good responses to the application of phosphate, phosphate + nitrogen, and phosphate + nitrogen + potash were observed. In 1934, in Kelantan, it was also found that cowdung and green manure gave good results.

At this point, it should be made clear that manuring in some form is by no means unknown in peasant cultivation of rice in Malaya. In Kedah, it is an old established practice to apply bat guano, and, in Kelantan, any available ashes of refuse or wood known as *baja bakar* is put on the fields. In other parts of the country, padi seedlings are dipped in a paste of clay and burnt bones before transplanting. It is especially the case in Kelantan that almost any form of manurial application does good on the poor soils. The alluvial soils of Kelantan and Trengganu are distinctly different in character from those of the western States, although derived primarily from the same geological formations. Rice is grown in these eastern States even where the soils are very sandy, and the crops are consequently very poor. It is to be expected that fertilisers will give striking improvements in such areas. At Bachok, Kelantan, for example, trials showed a very large response to ammonium sulphate alone.

When it became possible to resume padi manurial experiments after the war, the experience of the past was used to guide proceedings, and it was sought to discover the reason why fertilisers applied to the soil in western Malaya did not have the expected effect. Two former outstanding problems were first dealt with by field experiments; the dipping of seedlings (*chelup*) and the effect of bat guano. The conclusion reached from *chelup* experiments was that this practice is a waste of time. Bat guano is an article of very uncertain composition, which can only be known by chemical analysis. Stocks of guano of known composition were set aside and used for experiments in Province Wellesley and Kedah. In Province Wellesley, it has been shown that bat guano is of positive benefit, increasing with rate of application, but its use is not economic. In Kedah, on good soil bat guano had no significant effect, and it is proposed to transfer the experiment to poorer soil where positive results may be expected.

In general, recent policy has been to study the effect of time and method of application as well as the type of fertiliser, and to experiment in places with fertiliser treatments which could not be economic in practice, but may serve to give a clue to the mystery. A guide to future work was seen in a successful experiment in Kelantan in the 1949-50 season. In this experiment, ammonium phosphate, in measured amount, was applied by hand beneath each plant singly, and at different times, 2, 6, and 10 weeks after transplanting. Increases in yield of padi of the order of 50 per cent. from application at 6 weeks and 10 weeks, and of 20 per cent. from application at 2 weeks were obtained. Chemical analysis of samples of plants showed that nitrogen supplied had been remarkably efficiently utilised for plant growth.

In the 1950-51 season an experiment was performed identically at a large number of sites in different parts of Malaya, in which exact doses of fertiliser were prepared beforehand in paper packets to be placed beneath the roots of single plants at about 6 weeks after transplanting. There were 12 different fertilisers or mixtures, and each was applied to 20 single plants. The doses were large, reckoned on an acreage basis, but the objective was to make certain of a response where such was possible. In consequence of the small number of plants in each treatment, any estimate of yield could only be accepted with reserve, but the objective was to obtain comparative results for future guidance.

The results of this experiment were disappointing in western Malaya because of their inconsistency. In general, nitrogen and phosphate were ineffective, but the two combined in soluble form gave responses. The clearest results were obtained in Kedah. On good soil in this State, phosphate was without effect, but nitrogen gave a response, and the combination of nitrogen and phosphate was still better, giving increases of the order of 30 per cent. On poorer soil in Kedah, the effects of nitrogen and phosphate alone were small, but the combination as ammonium phosphate doubled the yield of padi.

This same experiment produced the most remarkable results in Kelantan. The combination of nitrogen and soluble phosphate was effective, but best of all was the combination of nitrogen, phosphate and potash. On fertile soil the N.P.K. mixture gave a 70 per cent. increase in yield, and at a site on very poor soil, it gave a 25-fold increase of padi. Over all the 10 sites in Kelantan on which this experiment was done the average increase due to N.P.K. mixture was three-fold.

It should again be emphasised that the above experiment was exploratory, to compare the potentiality of different fertilisers on different soils, and is not one which is capable of direct application in advising padi cultivators.

Other experiments were conducted in western Malaya in the 1950-51 season, including the comparison of two types of rock phosphate, the broadcasting and placement of rock phosphate, different types of nitrogen fertiliser in presence of phosphate, and different times of application of nitrogen in presence of phosphate. As in the past, the results were

inconclusive and sometimes inconsistent, and nothing emerged that would be of immediate interest to the padi cultivator. Information of scientific value was nevertheless obtained, which will be utilised in further trials.

The story is rather different in Kelantan again. Apart from the small scale experiment with accurate doses of fertiliser for single plants, a standard fertiliser mixture was decided upon as a working basis for other trials. This was

2 cwts. sulphate of ammonia
2 cwts. single superphosphate } per acre.
¾ cwt. muriate of potash

One experiment was conducted on smallholders' land at Bendang Setek, where the soil is very sandy. The land was cattle-ploughed and tractor-ploughed, and, in each of these treatments, was manured or not manured with the aforesaid mixture. The average yield of all the unmanured plots was 88 gantangs of padi per acre, while the average yield of all the manured plots was 291 gantangs per acre. Altogether there was no difference in yield from the two forms of ploughing, but tractor ploughing was best with manure, while cattle ploughing was best when without manure.

Another experiment was on Kota Bharu Experiment Station. Following the success of hand placement of ammonium phosphate in 1949-50, the object was now to test the standard mixture when ploughed in deeply and when only harrowed into the surface, as well as when half the dressing was ploughed in deeply and half applied on the surface. The whole area of the experiment was mechanically ploughed to a depth of 8 ins. and harrowed while dry. The fertiliser was applied or not applied as requisite. To explain the result it will be simplest to quote the actual figures for yield of padi.

A.	Manure applied deep	423	gantangs per acre.
B.	Manure ½ deep ½ shallow	410	„ „ „
C.	Manure applied shallow	415	„ „ „
D.	No manure	329	„ „ „

The average increase due to manuring was thus 27 per cent., but statistical examination of the uncontrolled variations in individual plot yields indicates that the result barely reaches conventional significance. There is no doubt however that the yield gains are real and that the mode of application makes no real difference in the existing circumstances.

It is interesting to compare the effects of manuring on the medium clay, fertile soil at Kota Bharu with the poor, sandy soil of Bendang Setek. At the former site, where normal yields are over 300 gantangs, manuring gives an increase of less than 100 gantangs, and at the latter site, where the normal yield is less than 100 gantangs, manuring gives an increase of about 200 gantangs.

A trial was made at Gerai, Trengganu, on a fairly heavy clay soil. Five different varieties of padi were grown with standard fertiliser and

without. There was no significant difference in varietal response, and the average yields were:—

Manured plots	....	....	322 gantangs per acre.
Unmanured plots	....	....	234 „ „ „

The increase of 37 per cent. in yield due to manuring was statistically highly significant.

The experiments just described, in which a standard fertiliser mixture was used, entailed the application of the fertiliser before transplanting. Now, it was shown in the previous year, when applying ammonium phosphate by hand and placing beneath the soil, that the best result came from application at 6 or 10 weeks after transplanting. This indicates a problem still to be faced, that is whether the benefits from the standard mixture would be still greater if it was applied later. It is by far the most convenient way to broadcast the fertiliser before ploughing, or before harrowing if the land is drained free of water. To apply it when the padi is growing means either draining the field and treading in the fertiliser, or mixing with some diluent and putting it under the plants by hand. Further experiments are in progress to find out whether increased benefits will repay increased labour.

Again, the standard fertiliser treatment has proved a fairly successful choice but it still has to be determined whether a better choice could be made. Experiments are in progress in which the proportions of ingredients and the total rate of application are varied. A better balanced mixture may be found and smaller rates of application may prove to be sufficient, so either increasing the benefits or reducing the costs of manuring.

In connection with the above remarks, a supplementary trial was made by the State Agricultural Officer, Kelantan, in 1950-51 at 13 sites, on medium clay, clay loam, sandy clay, and very poor coastal sand. The manure applied was Malayan Fertilisers No. 1 Mixture (11.5 per cent. N, 8.6 per cent. P, 4.0 per cent. K) and was placed in the soil between rows of padi plants at 6 to 10 weeks after transplanting. The method of placement was by hand or foot, and it was found that one man could place fertiliser satisfactorily at the rate of ½ to 1 acre per day. The average increase in yield of padi for the whole series was 47.5 per cent., but whereas the increase on medium clay was of the order of 30 per cent., it was of the order of 80 per cent. on the coastal sands.

Dry Padi.

Up to this point, the discussion has been confined to wet padi grown in irrigated or inundated *sawah*. No attention has been given to hill padi, commonly grown under conditions of shifting cultivation, but there remains an extensive cultivation in Kelantan and Trengganu of padi which is grown on the flat without irrigation.

The land where this crop is grown receives very shallow cattle ploughing, and one result of mechanisation trials in Kelantan has been

to show that deep ploughing produces a substantial increase in crop. The first manurial experiment was at Melor in 1949-50, when ammonium phosphate was applied by ploughing-in, by harrowing-in after ploughing, and by ploughing-in half and harrowing-in half. The cultivation of the soil was uniform throughout. Unfortunately the experiment was not sufficiently replicated for statistical significance, but the result indicated a 50 per cent. increase in crop due to manuring, with no difference in respect of method of application.

In the 1950-51 season, the experiment was repeated, but this time the standard fertiliser mixture was applied. The average yields were—

Manure ploughed in	221	gantangs	per acre.
Manure harrowed into surface	217	„	„ „
Manure ½ ploughed in ½ harrowed in	220	„	„ „
No manure	123	„	„ „

There was a very significant increase in crop of 78 per cent., and no difference due to mode of application.

An observation trial at Melor combined times and depths of ploughing with manuring. The results confirmed the general idea that unmanured dry padi with shallow ploughing gives 100 gantangs per acre, manured with shallow ploughing gives up to 200 gantangs per acre, and manured with deep ploughing gives 225 to 275 gantangs per acre.

Also at Melor, the experiment was made of applying packets of fertiliser to single plants exactly as was done with wet padi elsewhere. It was evident that either nitrogen, phosphate, or potash when used singly was ineffective, and might even depress yields. The best result, of more than doubling the yield, was brought about by using a combination of all three nutrients in soluble form.

Conclusions.

Another year's fertiliser trials, like so many in the past, has failed to reveal any practical treatment which could be generally applied to increase the padi crop in western Malaya. In Kelantan and Trengganu, the beneficial effects of manuring with a mixture of commercial fertilisers have been so obvious that smallholders have spontaneously asked for assistance in the purchase and use of fertilisers.

The attitude of the Department of Agriculture towards this East Coast development is that the amount of information gained is too limited yet to justify making recommendations to use fertilisers for padi. The Department has acceded to requests for assistance only on the understanding that it bears no responsibility for the result. It is necessary to confirm the efficacy of fertilisers in many more localities, and also to determine whether repetition is equally successful or whether there is no real benefit in the long run. More evidence is required as to what is the best mixture, and different localities probably have different requirements. Further inquiries into rate, method, and time of application are vital to the economic factor, for the best responses occur where normal yields

are poor, and more fertile soils may benefit little. Extensive trials are being made in the present season, not only on Departmental land but on smallholders' fields, which may go far to clarify the position for next season.

In the case of dry padi, more confidence can be felt, and it may be said with little hesitation that a complete fertiliser will give a good increase in crop as it would with any other dry land cereal. But as in the case of wet padi, the best mixture and the most economic rate of application have still to be worked out.

IMPROVEMENT OF PADI VARIETIES IN MALAYA

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Introduction.

As has often been emphasised, rice is the basic food of more than 99 per cent. of the 5,000,000 population of Malaya, of whom about 12 per cent. are peasant padi farmers and their families, producing about 40 per cent. of the rice consumed in the country.

To sustain a contented padi growing population, contemporary with rapidly rising standards of living, and to increase or even maintain our standard of production in this important crop, improvements must be made in crop returns, grain qualities, and thus also in cash remuneration from surplus crop.

Improvements in variety characters are equally as important in this effort as are improvements in cultivation methods, and in water supply and control, and are given priority of investigational attention by the Department of Agriculture.

Much variety improvement work was done prior to 1942, but since the war centralisation of investigational control and intensification of effort has been maintained.

Local Varieties.

There are very many different varieties of padi grown throughout the Federation of Malaya, although the numbers, naturally, are more or less limited in each locality.

While governed by particular likes and traditions, and acquaintance with only a limited number of varieties, padi farmers, as a result of many generations of experience, have selected varieties adapted to the soil, climate, and water conditions of their *sawah*. Scientific examination, however, has revealed differences within each of these varieties, and in the existence of these differences lies the possibility of improvement.

Definition of Improvement.

The most valuable improvement is to increase the yielding capacity of padi varieties. But this must not be done if other valuable characteristics such as resistance to disease or pests, adaptability to climate, strength of straw, or the limited shattering of the grain, are thereby lost. These are factors which can be assessed in definite terms; other characters

such as the flavour of the rice and cooking qualities are more difficult to measure against any standard.

The process of "improvement" also covers the search for the best varieties suited to new areas developed by the Department of Drainage and Irrigation. Here there is little or no information to be gained from padi growers themselves. What little information may be available relates only to varieties suited to former conditions of irregular and limited water supply—factors which are radically altered by controlled irrigation.

An increasing, though yet small, demand also exists for varieties suitable for short off-season cultivation, which has heretofore been of rare occurrence, and research is needed to meet this.

Methods of Improvement.

Three methods are being adopted by the Department of Agriculture to isolate or develop varieties of padi with superior qualities, for popular cultivation. These are Variety Trials, Pure Line Selection and Hybridisation.

Variety Trials.

These are designed to select the best yielding varieties from among the numerous types grown in each padi area; to assess the value of the less well-known varieties in such areas; and to explore the possibilities of increased yield from varieties introduced from other areas of similar soil, climate and water supply.

Pure Line Selection.

Within any variety there is variation in the yield of individual plants. Examination of large numbers of individual plants, and the pure-line progenies of these individual plants in plant-to-line comparative trials, the selection of the highest yielding or best quality strains, and the subsequent multiplication and distribution of seed of these selected strains is a standard agricultural technique for improving yields and quality of that variety, and the output and quality of grain from the area of its cultivation.

Hybridisation.

This implies the crossing of two different varieties and the object is to combine the best qualities of both and to throw out the undesirable characters of either. Provided suitable parental varieties have been identified and used, hybridisation and subsequent reselection may be expected to give better results than pure-line selection within a natural population.

Summary of Progress To-Date.

Variety Trials.

These trials were started in 1947 and have been carried out at 49 Departmental Stations throughout the Federation. Three years is the

minimum period to even out annual vagaries of climate. The results are now being analysed, but more extended trials will be necessary before widespread application of individual types can, with confidence, be widely recommended.

As an example, however, it may be mentioned that in these variety trials in Malacca, Reyong 6, from Kedah, has given much higher yields than the local Nachin 11, which is at present the standard padi variety of that area. The next steps are to test this apparent superiority of Reyong 6 in a large number of "field" trials outside the Padi Experiment Stations, and then to build up local supplies of seed.

Similar results are being obtained in some parts of Kelantan where Siam 29 has given good yields. Recent trials indicate that certain other varieties will give yet higher yields. The stage has not yet been reached where these other varieties can confidently be recommended.

In the irrigated *sawah* of West Pahang the variety trials have shown that Siam 29 from Pulau Gadong Padi Experiment Station, Malacca, and Mayang Ebos 80 and Radin China 17 from Telok Chengai Padi Experiment Station, Kedah, will give much higher returns than any of the local varieties.

Pure Line Selection.

This work is being carried out on nine major padi varieties at Padi Experiment Stations in seven of the most important padi growing regions, as follows:—

Variety			Region
Nachin	....	....	Malacca
Serendah Kuning	....	....	Negri Sembilan
Radin Ebos	....	....	Kedah
Mayang Sa Batil	....	....	Penang
Siam	....	....	Malacca
Seraup	....	....	Krian, Perak
Acheh Puteh	....	....	Selangor
Mayang Sa Gumpal	....	....	Kelantan
Anak Naga	....	....	Kelantan

It is too early to forecast results, except perhaps with Nachin and Serendah Kuning, on which selection has been in progress for some years. With these varieties, preliminary field trials have been made this past season, and it was shown that the yield of the best selected strains exceeded the average of 10 good strains by some 30 per cent. These results are very encouraging but must be confirmed by much further field experimentation.

In one of the field trials, one of the selected strains of Serendah Kuning has impressed local padi planters, and, to meet the pressure of demand by the local farmers, limited releases of seed of this selected strain have been made. The Department has, however, made no guarantee of "all season" performance of this seed.

Hybridisation.

In 1948, a collection of padi varieties was commenced in order to examine the characters of each as a necessary first stage to crossing. In Kelantan the collection comprises 300 East Coast varieties, in Krian 160 long term varieties, and in Malacca 450 medium term West Coast varieties.

Crossing between varieties commenced in 1950 in Malacca. This work, which is in its infancy, will not yield applicable results for many years.

The actual technique of crossing has not yet been fully developed, and as indicated in the earlier introductory paragraph on hybridisation the first results of crossing require much reselection and study before the desired improved types can be recognized. Many disappointments are inevitable.

The Effect of Improved Padi Varieties on Yields.

The principal object of improvement work is of course to increase the yield of rice obtained from given resources in the form of land, labour and capital. In this connection Malaya already compares well in its average yields per acre with other tropical countries. At 0.40 tons per acre our yields are on the average very slightly less than those obtained in Siam and Java, but appreciably greater than those recorded in India, Indo-China, the Philippines or Ceylon. Such yields are, however, still low compared with those obtained in sub-tropical climates (e.g., the U.S.A., Formosa, Japan, Australia and the Mediterranean) where crops range from 0.60 to 1.60 tons per acre. Such high yields reflect the result of a number of factors such as climate, intensive water control and cultivation, fertilization, and a specialised selection of padi varieties. It may be noted, however, that in Malaya yields in the areas such as the Krian Coast rise as high as 1.25 tons of rice per acre, and it seems reasonable to hope that if the improvement work referred to above is successfully pursued and its results taken into general use, the average yield of rice in the country should be increased by fully 10 per cent. This would correspond to an addition of perhaps 50,000 tons to our annual crop from the present acreage. This would be equivalent to the addition of $20 million at current prices to the gross national income compared with which the annual cost of the improved work now being undertaken is a mere $120,000 a year.

MECHANIZATION

Quarterly Progress Report, April to June, 1951.

Compiled by the Senior Agricultural Officer (Research) and the Agricultural Officer (Engineering).

Recent Importations.

The following tractors and implements have been received recently:—

Two Ferguson TE-A 20 tractors.
Two Ferguson 16 ins. single-furrow ploughs.
Steerage hoe for Ferguson tractor.
Front-mounted tool-bar for M.G.2 tractor.

Tests and Modifications.

Ferguson Rear Extension Wheels.

A pair of steel, rear extension wheels which were made some time ago in Province Wellesley for use in conjunction with pneumatic tyres have now been modified whereby they are entirely enclosed in 3/16 in. mild steel plate. The outer covering plate is concave from rim to hub thus preventing mud from clogging up the wheels without interfering with wheel removal.

These extension rims, which are illustrated in Plates I and II, are slightly smaller in diameter than the pneumatic tyres so that they can be fitted in the workshop and the tractor driven along roads and put straight to work in the padi field without further adjustment.

Fordson-Ransomes Mounted Plough.

The "F-R" three-furrow, semi-mounted plough was converted to a two-furrow implement in 1949, when its weight was reduced to 575 lbs. However, for padi cultivation it was considered that further weight reduction was desirable and, since the depth-control wheel was ineffective in wet padi land, this was removed together with its ancillary equipment, and conversion to a fully-mounted plough thus effected. This resulted in a weight reduction of 220 lbs. and increased efficiency for wet padi work. The implement, which is illustrated in Plates III and IV, has since been used, with complete success, for contract ploughing of 35 acres of wet padi land in Province Wellesley.

A Ransomes M.G.5 tractor has been very effectively water-proofed for use in wet padi land in Province Wellesley. This is illustrated in Plate V.

Investigations into Wet Padi Cultivation.

Investigations are continuing on depth of cultivation and off-season cropping at several localities. At Pulau Gadong, Malacca, experimental ploughing to depths of 4 and 8 ins. was carried out without difficulty

using a McCormick Deering 212 two-furrow disc-plough pulled by a Fordson Major tractor. Harrowing was later carried out with Martin disc-harrows and ridges for off-season cultivation were thrown up with a Ferguson disc-terracer. Sweet potatoes, groundnuts and leguminous green manures were planted on the ridges, and the first-named crop grew very well indeed. Growth of the green manures was satisfactory but the groundnuts germinated unevenly.

Disappointing results were obtained in Province Wellesley where off-season soya beans and maize were successfully drilled, on the flat, with a pair of Planet Junior seeder units mounted on a Ransomes M.G.5 tool-bar. This seed was later covered, using a locally made rake-like toothed harrow and a drum-roll with water ballast. (Plate VI). Unfortunately, the land was later water-logged after heavy rain and germination of the off-season crops was negligible. It may be concluded, therefore, that, on the west coast, it is essential to grow off-season crops on raised beds or ridges.

The difficulties which were encountered in the combine-harvesting of the wet padi crop at Bukit Merah in Province Wellesley are illustrated very graphically in Plates VII and VIII.

Investigations into the Cultivation of Dry Land Crops.

An experimental layout for the irrigation of dry land crops has been designed and laid down at the Federal Experiment Station, Serdang. The installation, with a double-acting ram pump and 3 ins. main, is complicated and expensive but it was designed for maximum flexibility and not as a commercial layout.

A Guinea grass experiment was planted within the irrigable area in April and, with the help of irrigation, establishment and early growth was very rapid. Later it is intended to superimpose three fertiliser treatments on three levels of irrigation.

The Guinea grass was planted at 1 ft. spacing on ridges spaced 28 ins. apart. Inter-row cultivation has been found to be extremely simple, consisting of scraping down the sides of the ridges with a Ferguson steerage hoe followed by ridging them up again with a Ferguson ridger.

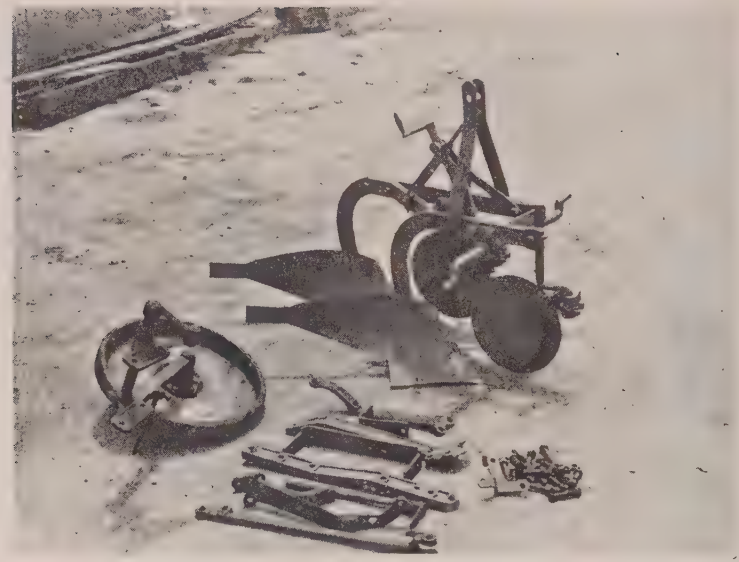
PLATE I.

Steel extension wheels fitted to a Ferguson tractor.

PLATE II.

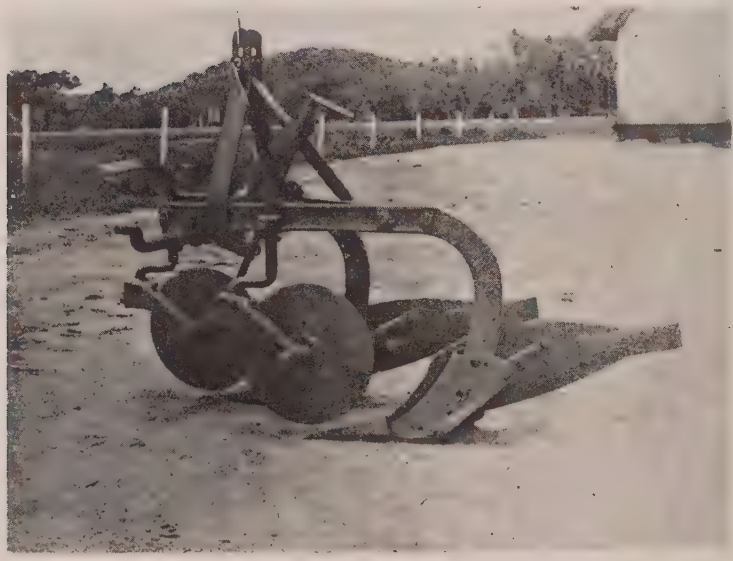
Steel, rear extension wheel enclosed with 3/16 in. mild steel plate.

PLATE III.



The Fordson-Ransomes three-furrow, semi-mounted plough, converted to a two-furrow implement, with the depth-control wheel removed, i.e. converted to fully-mounted plough.

PLATE IV.



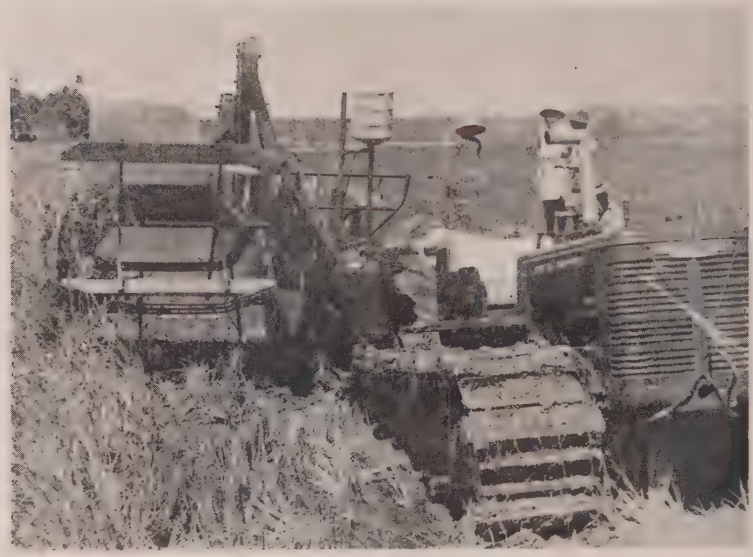
The modified Fordson-Ransomes mounted plough.

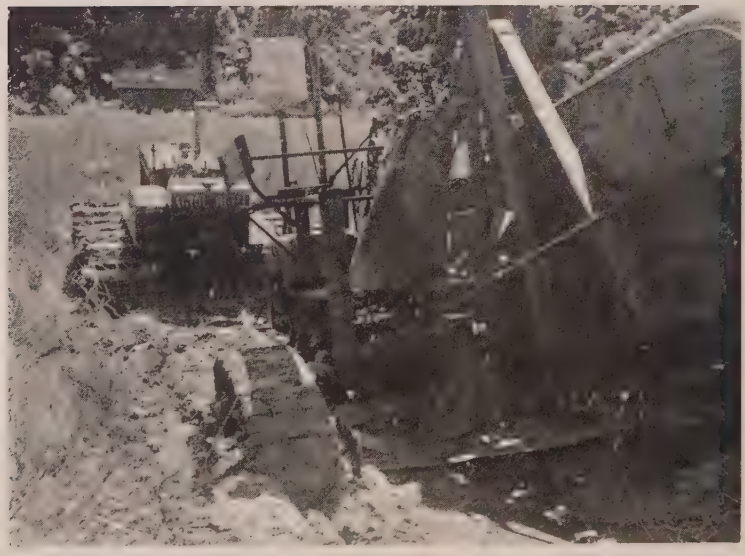
PLATE V.

A Ransomes M.G.5 tractor effectively water proofed.

PLATE VI

A Ransomes M.G.5 tractor with locally-made toothed harrow and drum-roll.





Views of a track-tractor and combine harvester bogged down at Bukit Merah in Province Wellesley.

NOTES ON CURRENT INVESTIGATIONS, APRIL TO JUNE, 1951.

Compiled by the Acting Chief Research Officer and the Senior Agricultural Officer (Research).

Padi.

Preliminary analysis of records of selection experiments has been completed for all varieties except Acheh Puteh, and the number of lines to be carried forward decided. The list of lines is as follows:—

	1950-51	1951-52
Serendah Kuning	67	67
Nachin	75	75
Siam	456	184
Mayang Sa Batil	188	90
Seraup	704	300
Radin Ebos	373	170

The results of the 1950-51 variety trials are in process of analysis and in most cases confirm the previous season's results.

Statistical analysis of last season's manurial experiments is proceeding very slowly owing to pressure of other work, but a comprehensive series of new experiments has been designed for the coming season, and some of these trials have already been laid down. No further significant results of interest have come out of cultivation trials. A sowing trial on muck soil on the Selangor coast gave an interesting result. Padi of the variety Acheh Puteh was broadcast on unreplicated, one-sixth acre plots at different rates of 25, 45, and 65 lbs. per acre, and, without manuring, the respective yields at harvest were 598, 622, and 670 gantangs per acre. An adjacent half acre block of transplanted padi of the same variety yielded 455 gantangs per acre. The maturation period of the broadcast padi was about a month shorter than that of the transplanted padi, and also its ripening was very rapid and even, which would be a great advantage if mechanical harvesting was intended.

A trial of drilling seed-padi, i.e. dry padi, at Melor, Kelantan, indicated that the best yields were obtained from the higher seed rates and closest spacing, which was 7 ins. in this case. As the highest seed rate used was only 25 lbs. per acre it is probable that it would be beneficial to increase it further. A NPK. fertiliser experiment on dry padi produced an increase in yield of 79 per cent., and this was not influenced by the depth at which the fertiliser was placed in the ground.

Tests were made on the germination of padi seed, in sterile conditions on filter paper, after treatment with various fungicides. One commercial product, an organo-mercurial dust, suppressed germination completely, and another almost completely. Germination was 100 per

cent. in other cases, and the most satisfactory growth, coupled with absence of fungi, resulted from steeping the seed for 1 hour in 1 : 1,000 mercuric chloride solution.

Means of controlling padi stem borers are being actively investigated. Seedlings which had their roots immersed in a systemic insecticide of 0.025 per cent. strength for 24 hours gave evidence of producing many more unattacked tillers than those seedlings which were not treated, but the wide range of variation calls for more replications. Pupae of the parasitic Tachinid fly *Paratheresia claripalpis* de Wulp. have been imported from Trinidad and, after initial difficulties with mating, experimental inoculation of stem borers *Proceras* and *Chilo* with the maggots has commenced.

The insect referred to on page 44 in the January issue of the Journal as *Erythroneura* is really *Typhlocyba.*

Cacao.

The second clonal trial of Trinitario propagated by cuttings was completely planted up at the Federal Experiment Station, Serdang. In the first trial plot, 10 per cent. of the plants were flowering at 18 months. A block of Serdang-Cheras Trinitario clones, has been planted on an estate.

A trial of 16 legitimate Serdang-Cheras progenies was planted at Serdang. In another trial, such seedlings have been found flowering at the age of 15 months.

A total of 900 seedlings of 10 different types of Trinitario cacao, raised from imported seed in the Pulau Tekong nursery, have been planted in a field prepared at Serdang.

Among the Amelonado plants raised from seed imported from West Africa, 70 were flowering at the age of 15 months and 80 cherelles were to be found. In order to accelerate multiplication of this material, vegetative propagation is being practised, by cuttings removed as prunings and by buds placed on Trinitario stocks.

The illegitimate Criollo seedlings established at Serdang are growing fairly well.

Further experience of budding cacao has shown that stocks require different treatment according to whether they are in baskets or in the field. A stock budded in the field should be bent over or ring barked if too large. If it is cut back too quickly it dies. A stock budded in a basket should be cut back to the bud patch as soon as a union has been established. Bending the stock leads to dormancy in the bud. By using these techniques 70 to 90 per cent. successes have commonly been obtained.

The open air spray propagator for cuttings is not yet completely successful. Improvement has been effected by prolonging the spray for an hour longer in the evening. Sawdust as a propagating material is receiving further trial.

Very dry weather in June caused a set-back to several cacao experiments planted on cleared land at Serdang and elsewhere, the trouble being seemingly due to movements of dry air. Extra secondary shade of bananas

and *Erythrina subumbrans* was planted, palm leaf shelters were erected, and existing shades were encouraged by extra manuring. Health remained satisfactory in all blocks under jungle shades. The river alluvium of Degong Agricultural Station, near the inland boundary of the Perak coastal plain, has so far proved very suited to the growth of cacao and also to bananas.

Specimens of seedlings or young trees suffering from die-back have frequently been received. Usually, *Fusarium* sp. and *Diplodia* sp. were present in the tissues and the alga *Cephaleuros* was frequently found on the bark. In all cases the die-back was due to factors other than fungus attack. Failure of budgrafted plants was associated with invasion of the stock by *Diplodia* sp.

Three species of *Phytophthora* which occur in Malaya were grown in pure culture for the purpose of experimental inoculation into plants and pods of cacao. It was only one species, *phytophthora palmivora* (rubber strain), which causes Black Stripe of *Hevea*, which penetrated beyond the point of inoculation. This fungus penetrated both wood and pod tissue deeply, so it is not unlikely that when the area under cacao increases and extends into the neighbourhood of rubber on low lying ground where black stripe is prevalent, damage will be done to cacao stems and pods.

Oil Palms.

Legitimate seedlings of dumpy palms numbering 6,500 were delivered to an estate during the quarter, making a grand total of over 20,000 in existence on estates and at Serdang. On the basis of 5 years' records, eight of the dumpy palms at Serdang have been finally selected and are now used for the production of legitimate seed. An observation plot of 1,000 palms of progenies (152 x 206) and (206 x 206) was planted on an estate for future selection.

As a result of crossing dumpy palms with pisifera pollen from Nigeria, two mature fruit bunches have been harvested. A second consignment of pisifera pollen has been used for crossing with one dumpy and three selected normal palms.

Seed of tenera palms imported from Nigeria has germinated, but very few of the Dura x pisifera seeds imported at the same time have yet done so.

Selection of normal palms at Serdang has been made on the basis of 5 years' records, and 16 palms from eight families are being used to produce legitimate seed.

There is evidence from analysis of 5 years' records that there is, in most families, a correlation between yield and girth and also between yield and height. In the case of greater girth, palms tend to produce larger but not more numerous bunches. In the case of greater height, the explanation is probably to be found partly in the fact that the tall palms shade the smaller ones. Care has to be exercised in selection to distinguish an environmental as well as a genetic factor in the yield of tall palms.

The influence of soluble aluminium in the soil on the health of oil palms is under investigation. Aluminium is a normal constituent of oil palm leaf, and on 15 palms taken at random over all parts of the plantation at Serdang, the aluminium content of dry leaf varied from 0.03 to 0.09 per cent. The average amount of aluminium in the ash of the leaf was 1.37 per cent. Oil palm seedlings grown in nutrient solution not only tolerate but prefer acid solutions, and when grown for alternate weeks in nutrient solution and in aluminium sulphate solution containing 1.63 g. of aluminium per litre evinced no signs whatever of distress. These latter seedlings did not contain an abnormal amount of aluminium in the leaf, although the amount in the roots was considerably greater. It would appear that when oil palms suffer from wilt and die-back in acid soils, the effect is not due to acidity or to soluble aluminium.

Helminthosporium Leaf Spot.

In an investigation of *Helminthosporium* attack on oil palms on an estate, seedlings were grown on the estate soil in pots and were inoculated, in the crown, with the fungus. Where the pots were watered daily, the inoculations made no progress, but where the pots were watered weekly the fungus developed and the plants were killed in two months. Seedlings in pots which did not receive adequate water but were not inoculated, survived in spite of withering of older leaves. Protection against *Helminthosporium* attack in the field is expected to be afforded by conservation of moisture in the soil.

Vascular Wilt.

Hitherto the internal stem symptoms of vascular wilt had not been encountered in palms affected with leaf bending and cracking. A specimen has now been received with well marked blackening of the vasculars, but no *Fusarium* fungus could be isolated from it nor could any fungus mycelium be seen.

Coconuts.

Preparations have been made for a factorial manurial experiment on poor inland soil at Serdang. Nurseries have been planted and the experiment site is being cultivated.

An unexpected, exotic pest was discovered to have established itself in the neighbourhood of Kallang Airport, Singapore. This was the Philippine leaf-mining beetle *Promecotheca cumingi* Baly. This beetle was seen previously, in 1917, at Malacca where, after doing some damage, it died out. It is not thought that the present invasion is spreading with such rapidity as to occasion apprehension, but it is being kept under observation.

Fibres.

Ramie.

Sixteen clones were planted in a clonal trial at Serdang. A factorial manurial trial is being laid down on coastal peat soil, in which the treat-

ments will consist of all combinations of the presence and absence of burning, liming, inorganic N.P.K., and organic N.P.K. Ramie is included among plants being tested in pot trials on the same peat.

Jute.

Jute trials have been disappointing, except on the muck soils of the Selangor coast. An experiment on this soil to test jute against Roselle was a partial failure because the young Roselle cuttings were mostly killed by floods.

Manila Hemp.

A Manila hemp and rubber spacing trial was planted on an estate in Johore.

Seeds of *Musa textilis* were obtained and planted, but germination and subsequent growth have been slow. The seedlings are to be used for transmission tests with the aphid *P. nigronervosa,* previously fed on specimens of hemp and bananas at Serdang which are suspected of possibly harbouring bunchy top virus. Further suckers from backward hemp plants at Serdang have been planted in manured soil at Kuala Lumpur. Some previous specimens had already made good growth without showing any symptoms of virus. No symptoms of virus could be found on any of the Manila hemp growing at Port Swettenham Experiment Station.

The large cultural experiment at Port Swettenham has given convincing evidence of the need for the best possible drainage on heavy coastal clay. The success of the experiment is seriously threatened by the acute labour shortage and consequent difficulty of keeping down weed competition, especially *Mimosa,* until the hemp is sufficiently grown to provide shade.

Tea.

A full year's observation has been made of the incidence of Blister Blight, *Exobasidium vexans.* As foreseen, there is likely to be a build-up of the disease in the period October to December, which tends to decrease in January to March, but again builds up in April, and is slight during the period June to September. The effect on the disease and on the crop of various fungicidal applications is being tested, and certain bushes exhibiting resistance are under observation for selection. A study is being made of the fungus *Exobasidium vexans* itself. One of the observations is that, under conditions favourable to the fungus, leaves develop blisters which sporulate 12 days after artificial inoculation. In the field, the period of spore production on the blisters is 7 or 8 days or less, mainly because of invasion of the blisters by other fungi. The effect of a spell, since February, of weather at Tanah Rata unfavourable to the fungus has been to allow bushes which were not sprayed after pruning to make some measure of recovery.

Records of incidence of Blister Blight on lowland estates are being collected. The fungus does little damage and is present only during prolonged damp weather.

Coffee.

In the early stages of a variety and shading trial, Liberian v. Uganda, at Serdang, there is an indication that Liberian coffee yields better in the open than under leguminous shade. Uganda coffee seems to be more tolerant of shade and may derive eventual benefit. Two hybrid coffees, Kawisari and Kalimas have come into bearing.

Nurseries have been established for a comparative trial of Mysore and Blue Mountain *Coffea arabica,* to be laid down at Cameron Highlands.

Fodders.

In the factorial manurial trial on Guinea grass at Serdang, statistical analysis of yield figures still shows a marked linear response to potash and nitrogen, with a significant interaction between these two treatments. Grass on plots which do not receive potash is dying out. The strong influence of rainfall on yields of fodder grass causes great interest in the impending extension of the Guinea grass manurial experiment to an area laid out for irrigation at will. Reference to the irrigation equipment will be found on page 132.

Aeschynomene Americana is growing satisfactorily and seeding lightly both at Serdang and Kuala Lumpur. The foliage is palatable to goats but the plant tends to become woody. *Stylosanthes sundaica* is a recent introduction which has by no means had the outstanding success of *Stylosanthes gracilis,* but is a dwarf creeper which might prove useful in a pasture.

There was a rather sudden outbreak of caterpillars in Singapore, destroying 60 acres of Napier grass intended for dairy cattle. The pest was found to be an army worm, *Cirphis unipuncta* (Haw.), and was brought under control by benzenehexachloride applied in various ways. Another army worm, *Laphygma exempta* Walk. was responsible for a subsequent smaller attack.

On the said Napier grass, there was a heavy attack, while young, of blast (*Piricularia* sp.) in plots manured with nitrogenous fertiliser. The later growth was free from attack, as was the grass in unmanured plots.

Pastures.

The ever present pest of pastures, *Mimosa pudica,* shows signs of being sufficiently susceptible to control by the aromatic oil Sovacide P.Y. to justify continued trials.

Pineapple.

Work is in hand preparatory to opening up the new Federal Experiment Station at Alor Bukit in the Pontian district of Johore. An extensive programme of investigation awaits execution in the botanical, cultural, and plant protection spheres. The prevalence of pineapple wilt is no small menace to the industry and is mainly the work of the insidious mealy bug. Laboratory investigations are in progress, and field insecti-

cidal trials aimed at controlling mealy bug are planned. In a co-operative experiment on a plantation in South Johore, an investigation has commenced to determine the effect on fruiting season of spraying the crop with very dilute solutions of alpha-naphthoxy-acetic acid. As would be expected from the results of the practice in other countries, early observations suggest that the treatment increases the uniformity of fruiting.

Miscellaneous Crops.

A factorial manurial trial on bananas has been designed and sites have been selected on three Agricultural Stations, with more to follow if possible.

In three rambutan variety trials, the trees are showing good growth, and some clones are expected to fruit shortly.

A consignment of seed potatoes was received from Holland, and a series of variety and disease-resistance trials have been laid down at Tanah Rata Agricultural Station, Cameron Highlands. This importation of seed is intended to follow up investigations carried out in 1949 and 1950. In connection with these trials, some of the seed was successfully sprayed with dilute alpha-naphthoxy-acetic acid to delay sprouting.

Also at Cameron Highlands, in a pe-tsai * variety trial, both American and Australian varieties easily out-yielded the local strains grown from Chinese seed. In a large variety trial of Chinese radish, to compare nine Japanese varieties with the local Chinese, the best yielder was Minokokonoka which gained the approval of local wholesalers for quality. Other promising varieties were Akizumari, Minra, and Shogoin Daikong. Long term investigations on the manurial response of Highlands vegetables are continuing.

Off-season food crops on wet padi land have been under trial at several localities. Groundnuts have shown promise both at Talang and Selinsing, in Perak, and also soya beans have grown vigorously at Talang. Various other trials on such land have been complete or comparative failures.

A maize variety trial was conducted at Kuala Lumpur to compare local and imported strains. The land was given a light dressing of compost together with complete fertiliser, and the time from sowing to harvesting was 113 days. The highest yield was 3,111 lbs. per acre from Local Red, but this was not significantly greater than Burma Yellow, Local Flint and Fitzroy (Australian), a dent type. Burma White yielded over 2,000 lbs. per acre, whereas three Australian dent types were rather low yielding. In general, the small seeded flints of local origin performed the best.

A second maize variety trial was laid down to compare eight imported hybrids with local flint. Early growth was fair, but all plants became attacked by *Helminthosporium* leaf spot and four strains were seriously affected, becoming a matter for investigation by the Division of Plant Pathology.

* Chinese cabbage

Other experiments on *Xanthosoma*, soya beans, climbing French beans, cucumber, groundnuts, and lettuce reached a preliminary stage and awaited further developments.

Soils.

The causes of apparent toxicity of certain soils continue to be investigated. In swamp soils, the elements most suspected are sulphur and aluminium.

In Malacca, soil samples were taken from a fairly dry area near Duyong carrying a pure stand of "gelam" *Melaleuca leucodendron*, and from the Pulau Gadong Padi Experiment Station. The Duyong soil contained little sulphur, but there was over 2 per cent. sulphur in the Pulau Gadong samples. The Duyong gelam contained 0.578 per cent. of sulphur in the stems and 0.639 per cent. in the roots. A piece of hard black wood (not gelam) in the subsoil at Pulau Gadong contained 1.753 per cent. sulphur. Samples are now being collected in order to find the order of sulphur content prevailing in gelam and other swamp timber species.

In investigating the toxicity of aluminium to padi seedlings, soils from the Paya Besar Irrigation Scheme area, known to have a high content of active aluminium, were mixed with sand and used for germination of padi. The padi either did not germinate or, if it did, the seedlings died off when not more than ¼ in. high. When reasonably good yielding padi soil was used as a substratum and aluminium sulphate solution was added, amounts up to 200 p.p.m. Al_2O_3 appeared to have a slight stimulant effect. Up to 600 p.p.m., the effect was not serious but beyond that, increasing additions of aluminium caused progressive browning of the leaves. The symptoms were similar to those observed with Paya Besar soils. In laboratory tests made to ameliorate Paya Besar soils, treatments with soluble phosphate did not show any promise, but treatment with lime had a pronounced beneficial effect.

In studying the fertility of Selangor coastal peat, a quantity was brought to Kuala Lumpur for pot trials. The plants under test are ramie, soya bean, maize and tomatoes. Different rates of liming are applied, also copper sulphate, and both lime and copper sulphate with the addition of N.P.K. The best growth at first appears to be from a combination of 10 tons of lime and 50 lbs. of copper sulphate per acre. In the case of ramie there were additional treatments of burning the surface peat in the pot, and burning the same amount of peat elsewhere and replacing the ashes in the pot. Also, the equivalent of the ash in terms of K_2O and CaO was separately applied. There was evidence that burning the surface of the peat was more beneficial than adding peat ash, but plain liming was probably still better. These trials are still in progress.

Information is being sought on the movement of water in the very heavy clay soil at the Federal Experiment Station, Port Swettenham. Thirty bore holes have been sunk, spaced at different distances from deep, open drains. Initial observations are that ½ in. of rain in a day quickly raises the water table in wells at 20, 25 or 30 ft. from drains by as much

as 15 to 25 ins., and if there is no further rain the level falls to its previous position in two to three days. A ½ in. rainfall causes only a slight rise in wells 5, 10 and 15 ft. from drains and this quickly drops back. A heavy rainfall of over 1 in. in a day causes a rapid rise in all wells, but the level falls very quickly in wells not over 15 ft. from drains. It is intended to continue taking daily records over several months.

An experiment on the effect of added trace elements on the growth of padi in pots has been concluded without any positive results. All treatments have been severely attacked by stem borer.

Oil palm seedlings were planted in large pots of jungle soil, untreated, and limed at the rate of 10 and 23 tons per acre. The pH values of the soil were 4.6, 7.8 and 8.1 respectively. Growth was excellent in the untreated soil, but very poor in the heavier limed pots, with dying back of leaves. In the soil with moderate liming, growth appeared to be a failure at first, but subsequently it was vigorous, although the plants were far behind the controls in size. The object of these trials was to observe the degree of tolerance of the oil palm to high pH in soil, in relation to the demand for acidity when growing in nutrient solution. The trials are continuing in poorer soil.

Soil samples are being taken, at monthly intervals, of soil under mulches of padi husk and sawdust, and left bare as control. As was expected, when there had been rain the previous night, the control contained more moisture than the mulched plots, but in the absence of rain the reverse was true. The organic carbon is consistently, but only slightly, higher in the mulched plots. Other tests of aggregation and water holding capacity are being carried out.

Livestock.

Goats.

During the quarter the following live kids have been born at Serdang.

Toggenberg	pure-bred	....	1 female
„	¾-bred	....	2 males, 1 female
„	½-bred	....	2 males
Saanen	½-bred	....	5 males, 4 females.

The total milk production amounted to 3,435 lbs. British Alpine Doe No. 4 has averaged 6½ lbs. of milk per day since kidding on the 25th February. The half-bred Toggenberg Doe No. 117 has given 4¼ lbs. of milk per day since kidding on the 27th May.

Poultry.

In the feeding and management trials, live-weight gains and egg production mostly favoured the Serdang ration as compared with the variable kampong one.

NOTES ON EXTENSION WORK, APRIL TO JUNE, 1951

Compiled by the Chief Field Officer.

Padi.

Selected Seed.

The majority of the pre-war selections were lost during the Japanese occupation and it was, therefore, necessary to make a fresh start, in 1946, with selection and breeding work. This work is expected to produce results from 1953 onwards. In the meantime, however, certain selected strains of Radin Ebos, Siam and Nachin which survived the war are still in demand in areas where they have become established, notably in Kedah and Malacca. Distribution of seed of these strains during the quarter under review totalled 5,984 gantangs.

Mechanical Cultivation.

The Rural and Industrial Development Authority schemes for ploughing padi land, which got under way during the quarter in Kelantan and in the Tanjong Karang area of Selangor, are based on work carried out by the Department of Agriculture.

In Kelantan, investigation work by the Department has shown that the ploughing by tractors of dry padi land increases yields in the order of 50 per cent., with a residual effect in the second year and possibly longer. These results have considerably impressed the local cultivators, leading to a demand for tractor ploughing on a contract basis which R.I.D.A. has taken action to meet.

In the Tanjong Karang area, work carried out by the State Agricultural Officer, Selangor, during 1950, in ploughing padi land on contract for the cultivation of off-season crops is this year being extended by R.I.D.A.

In Province Wellesley, ploughing of padi land on contract remains, for the time being, in the hands of the Department.

Manuring.

Following the success with fertiliser experiments in Kelantan, arrangements have been made for field extension trials on a considerable scale during the 1951-52 season.

Rubber.

Extension work among rubber smallholders is carried out by the Smallholders Advisory Service of the Rubber Research Institute, working in conjunction with State or Settlement Agricultural Officers and their staffs.

C.D. & W. Scheme No. D. 1176—Supply of Planting Material to Smallholders.

Distributions of approved planting material from nurseries maintained by the Rubber Research Institute and the Department, during the quarter, were as follows:—

Budwood	4,138	yards
Clonal Seedling Stumps	218,580	
Germinated Clonal Seed	198,265	

Owing to the present high price of rubber, replanting is not being actively pursued and the supply of planting material greatly exceeds the demand.

A representative batch of 25 youths is now undergoing the third of the series of technical training courses at the R.R.I. Experiment Station, Sungei Buloh.

Planting Methods.

Demonstrations of hedge-planting are being carried out on small-holdings in Johore.

Processing and Marketing.

Schemes for centralised manufacture of sheet rubber are under way in Perak and Malacca, and R.I.D.A. has a number of such projects under consideration.

The sale of latex in bulk continues to operate satisfactorily in parts of Johore, Selangor, Perak and Kedah.

Coconuts.

Little interest is being shown at present in the improved kilns designed by the Department. The reason in the majority of areas is the adverse effect of the price margin between wet and dry copra.

Fruit.

Action is being taken in a number of States and Settlements to increase the production of budded fruit trees for distribution purposes. Distribution during the quarter totalled 2,700 budded plants, with Johore well in the lead.

Pineapples.

The State Agricultural Officers, Johore and Selangor, have continued to pay considerable attention to the problems of the small grower, particularly on the marketing side.

Pepper.

Certain Agricultural Stations are increasing the supply of planting material of this crop, for distribution purposes.

Cacao.

All planted areas of this crop, experimental and non-experimental, are being kept under observation by the Field Branch.

Livestock.

Pigs.

Plans are being made to increase the number of stud centres for Middle White boars.

Penang and Province Wellesley leads the field in pig extension work but the Middle White cross is now becoming popular in the Central District of Malacca, and 41 services were registered during the quarter at the Pulau Gadong stud centre.

Cameron Highlands Agricultural Station,which is the main breeding centre for Middle Whites, distributed a total of 43 animals to breeders during the quarter. The number of breeding sows at this Station is being increased.

Poultry.

Distributions of Rhode Island Red birds during the quarter were as follows:—

Cockerels, pullets and chicks	605
Eggs for setting	794

Selangor and Kelantan show the greatest developments as regards poultry extension work.

Goats.

Half-bred bucks of the British Alpine and Saanen breeds are at stud in Malacca and Kelantan respectively.

Resettlement Areas.

State and Settlement Agricultural Officers are advising, when requested, on the numerous agricultural problems affecting the resettlement areas, with particular reference to systems of agriculture and land requirements.

Ploughing by tractor, on contract, of arable land, attached to certain resettlement areas, has been carried out by the State Agricultural Officer, Selangor.

Review

A PROVISIONAL CLASSIFICATION OF MALAYAN SOILS

By G. Owen. Journal of Soil Science Vol. 2, No. 1, January, 1951.

This is the first published classification of Malayan soils in which nomenclature in agreement with modern pedological practice is used, i.e. names for the various soil series are place names where the soils series was first investigated or where it is particularly well developed. In this respect the suggested classification should help to clear up the misconceptions and confusions which have been common in the past due to the application of what were originally purely geological terms (and, in certain cases, now admitted by the geologists to be wrong) to describe soils.

In the proposed classification, the nature of the parent material is recognised as being the most important genetic factor and the most suitable basis for classification of local soils. Classifying the soil parent material in the order of geological age, we have, as the youngest group, the Recent Sediments which include all the alluvial soils. The older igneous rocks including the granites and rocks of volcanic origin are classed together. Still older are the formations of sedimentary origin laid down in the Triassic and Carboniferous periods. These include the shales, schists, phyllites and sandstones. Soils derived from limestone—the oldest of the Malayan formations—are confined to very small areas around the bases of limestone outcrops.

In the Recent Sediments, five soil series are recognised and named. These are: the Selangor Series, a dark-brown to blue-grey silty clay with impeded drainage; the Kelantan Series, where sandy deposits occur more frequently but which have also impeded drainage; the Sungei Buloh Series, coarse-grained loamy sands to fine-grained sandy loams, derived from bedded sands and sandy gravel and in which drainage is excessive; the Perak Series, an inland alluvial soil derived from alluvial parent material of mixed origin under conditions of impeded drainage; the Chemor Series, yellow to reddish-yellow sandy or clay loams, developed under conditions of free drainage. Peat is also recognised but no series name has been given.

With reference to the Selangor Series it is noted that these soils are not regarded as so good for rubber as the freely drained, inland soils and it is pointed out that they are better suited for shallow rooted crops, e.g. food crops.

In the soils from igneous rocks, two series derived from granite are recognised. The Rengam Series, covers the major proportion of the total area of granite soils. Soils of this series are derived from medium to fine-grained rocks and are reddish-yellow, friable, sandy clay loams often micaceous; they have a good physical condition and rubber trees

grow well. The Tampin Series is derived from coarse-grained, highly siliceous rocks giving a coarse-grained sandy loam, whitish-grey at the surface, changing into pale yellow below. The fertility of this soil is low.

In soils derived from volcanic rocks, only those from the basic rocks have been classified. Two soil series are recognised. The Kuantan Series is well represented in East Pahang and is a dark reddish-brown loam over clay loam, very friable and permeable with a distinctive fragmental structure and occasional concretionary ironstone. Roots of rubber trees are very well distributed throughout the profile. The Segamat Series, which has many characteristics in common with the Kuantan Series, is a deep brownish-red, heavy clay, friable and permeable with a mildly developed crumb structure and containing no gravel or laterite concretions. These two series comprise the most fertile of all the inland soils. Composition of the clay fraction reflects certain fundamental differences between the two, since percentage SiO_2 is much higher and percentage Fe_2O_3 much lower in the Segamat Series.

The soils derived from the more acid rocks of volcanic origin, the rhyolites and andesites, have not been classified as they have not been investigated.

The soils derived from sedimentary and metamorphic rocks of the Trias and Carboniferous periods have been subdivided into those derived from sandstones and those derived from argillaceous rocks. To the soils formed on sandstones, the name Kedah Series has been given. These are reddish-yellow, friable, sandy loams, suitable for rubber or other tree crops but unsuited for annual crops. Soils derived from argillaceous rocks include the Batu Anam Series, usually a yellow to yellowish-brown, silty clay loam over mottled, silty clay, which is widespread in areas of undulating and hilly land. Occasionally a narrow band of rounded concretionary laterite nodules appears at varying depths from the surface. The Malacca Series is found in flat or gently undulating terrain. A characteristic feature of this soil is the high percentage of ironstone or laterite. Growth of rubber trees depends largely on the depth of soil above the laterite. Soils derived from schists are classified as the Seremban Series. The soil is a sandy clay loam or sandy clay over clay in which yellow is the predominant colour. The fragments of laterite often occuring immediately above the partly weathered parent material have a structure resembling the parent material. This soil deteriorates rapidly on exposure.

The relationship of Malayan soils to the "great soil groups" is discussed and it is considered that the majority fall into the category of "latosols", a term recently proposed by Kellogg for soils having their dominant characteristics associated with low silica-sesquioxide ratios of clay faction, low base-exchange capacities, low activities of the clay and a relatively high degree of aggregate stability. The laterite of the Malacca Series is placed in the group of the Ground Water Laterites, i.e. the laterite which has been formed under the influence of a fluctuating water table.

In conclusion, the author emphasises the provisional nature of the classification and points out that the influence of relief, cultivation and erosion cannot properly be assessed until adequate detailed soil surveys are carried out.

It is to be hoped that this paper will receive widespread attention from those interested in the soils of Malaya and that steps will be taken to popularise the new nomenclature in order to overcome the confusion which has resulted in the past from loose and wrong terminology.

J.K.C.

Departmental Notes

Retirement of Mr. Gunn Lay Teik, O.B.E., M.A.

Mr. Gunn Lay Teik, who was born in Penang of an old Straits Chinese family, received his university education at Cambridge. He joined the Department in 1924 in the capacity of Assistant Analyst in the Division of Chemistry. In the course of the years, the variety of materials, the new and the familiar, which passed through his hands for professional attention was enormous. The work was often tedious but not without its humorous moments. Mr. Gunn for long remained much in the background as the trusty henchman of the Division, but the interest he particularly developed was animal nutrition. It was not till 1937 that he succeeded in getting leave to go to the United Kingdom for leave to study that subject in Cambridge, Aberdeen and elsewhere.

During the occupation of Malaya by the Japanese, Mr. Gunn was in the uneasy position of being necessary to the Japs as the only person of adequate scientific training available in the remaining staff, but suspect to them and liable at any time to fall a victim to their unpredictable savagery. On the liberation of Malaya in September, 1945 after warding off the temporary looting frenzy, Mr. Gunn was a much relieved man and as soon as he could be physically relieved in 1946, he lost no time in departing for England, escorting his sons whose education, after a strange hiatus, was henceforth to continue at Cambridge.

For more than 3 years prior to his retirement in May, 1951, Mr. Gunn has been Acting Senior Chemist, except for another interlude to visit England. Finally, on terminating his last tour of service, Mr. Gunn, like any native of that country, immediately set sail for U.K. where the number of his children at study has increased to four.

Mr. Gunn will be back in Malaya after no great length of time, and with his store of experience will have an active part to play in local affairs. He will be well supported by Mrs. Gunn with her past experience of public spirited work, and we wish them much happiness and success in the future.

T.A.B.

Promotions.

The Right Honourable the Secretary of State for the Colonies has approved the following promotions:—

Mr. E. F. Allen, Agricultural Officer, to be Senior Agricultural Officer (Research) with effect from 1st November, 1950.

Mr. E. J. H. Berwick, Agricultural Officer, to be Senior Agricultural Officer with effect from the 22nd February, 1951.

Dr. W. N. Scott, Agricultural Officer, to be Senior Agricultural Officer with effect from the 26th May, 1951.

Appointments.

Mr. N. Kanagaratnam, Agricultural Assistant, has been appointed Agricultural Development Officer with effect from 1st March, 1951.

Mr. J. K. Coulter, Acting Senior Chemist (Soils), has been appointed to act as Senior Chemist with effect from the 11th May, 1951.

The Right Honourable the Secretary of State for the Colonies has appointed Mr. F. B. Brown to be a Botanist, Malayan Agricultural Service, with effect from the 29th June, 1951. Mr. Brown arrived in Malaya on the 22nd July, 1951, and is stationed at Headquarters.

Transfers.

Mr. J. L. Greig, Senior Agricultural Officer, has been transferred, on promotion, to the post of Director of Agriculture, North Borneo.

Mr. H. D. Matheson, Agricultural Officer, was transferred from the Federal Experiment Station, Serdang, to the post of Settlement Agricultural Officer, Penang, with effect from the 10th June, 1951.

Mr. J. R. Milburn, Agricultural Officer, ceased to be seconded for duties in connection with the Emergency, and assumed duty as Agricultural Officer (Research) at Serdang, with effect from the 1st June, 1951.

The secondment of Mr. H. K. Ashby, Senior Agricultural Officer, ended also, and he assumed duty as State Agricultural Officer, Kelantan, with effect from the 8th June, 1951.

Leave.

The following officers have proceeded on leave:—

Mr. Gunn Lay Teik, Chemist, on leave prior to retirement, with effect from 11th May, 1951.

Mr. E. J. H. Berwick, Senior Agricultural Officer, with effect from 10th June, 1951.

Mr. P. G. Coleman, Agricultural Officer, with effect from 10th June, 1951.

Mr. G. S. Keeping, Agricultural Officer (Research), returned from leave on the 18th May, 1951, and resumed duty as Officer-in-Charge, Federal Experiment Station, Serdang, Selangor.

MARKET PRICES

April to June, 1951.

Rubber.—There was a decrease of 75 cents per lb. in the Singapore price of No. 1 R.S.S., f.o.b., in bales during the period 1st April to 30th June, 1951.

On the 2nd April, 1951, the price was 219½ cents per lb. but, in general, there was a downward trend during the month and the price had dropped to 187½ cents by the 30th. The average price for April was 198.08 cents per lb. There was a further decrease in price during May from 186½ to 149 cents per lb., the average price being 158.74 cents. On the 1st June the price was 148 cents, and from then on fluctuated between 143 and 152 cents, the price on the 30th being 145 cents. The average price for June was 147½ cents per lb.

The average prices paid for smallholders' rubber at three centres in the Federation of Malaya during the second quarter of 1951 are given in Table I.

Table I.

Average Monthly Prices Paid by Local Dealers for Smallholders' Rubber, April-June, 1951.

(Dollars per picul of 133 1/3 lbs.)

Grades	Taiping, Perak.			Seremban, Negri Sembilan.			Batu Pahat, Johore.		
	April	May	June	April	May	June	April	May	June
Smoked Sheet	191.00	159.00	159.00	213.00	170.00	162.00	186.63	158.25	139.25
Unsmoked Sheet	170.00	137.50	136.00	175.00	145.00	134.00	170.47	139.69	126.25
Scrap	80.00	55.00	60.00	72.00	57.00	55.00	39.38	31.44	36.25

Transport from Batu Pahat to Singapore by lorry, excluding duty, $1 per picul.

Tea.—The average price paid in Colombo for Malayan tea, as quoted in the Colombo Brokers' Association weekly report dated the 26th June, 1951, was Rs. 1.86 per lb.—23 cents lower than the average price for the first half of 1951. The average prices of Ceylon teas, as quoted in the same report, were as follows, in rupees per lb.: High Grown Teas 1.97, Medium Grown Teas 1.69, and Low Grown Teas 1.83.

Ceylon teas are subject to export duty but non-Ceylon teas sold at auctions ex-bond in Colombo are not subject to this duty.

Derris.—The price of this commodity, as quoted in the weekly reports of the Singapore Chamber of Commerce, remained steady at $95 per picul during April and the first three weeks of May. In the last week of May, the price increased to $105 per picul and remained there during June, 1951.

Tobacco.—The average prices paid per picul for cured leaf in Kelantan were:—1st quality $733, 2nd quality $458, and 3rd Quality $190.

Rice.—The ration of rice continues to be 3½ katis per week. The range of prices, in cents per kati, of the three grades of ration rice are as follows:—High Grade 32 to 36, Medium Grade 25 to 30, and Low Grade 19 to 21.

Table II.

Singapore Prices of Various Agricultural Products.

(Dollars per picul)

Date	Copra, Sundried	Coconut oil*	Pepper. F.A.Q. Muntok white	Pepper. Gen. Muntok white	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
1951								
2nd April -	52.50	94.00	1,055.00	1,065.00	80.00	24.00	28.00	16.50
9th April -	51.50	92.00	1,075.00	1,085.00	80.00	23.50	28.00	16.50
16th April -	49.50	90.00	1,105.00	1,115.00	80.00	23.50	28.00	16.50
23rd April -	47.50	87.00	1,085.00	1,095.00	80.00	22.50	28.00	17.50
30th April -	47.00	85.00	1,080.00	1,090.00	80.00	22.50	29.00	18.50
7th May -	43.50	83.00	1,050.00	1,055.00	85.00	21.75	28.00	19.50
15th May -	44.00	83.00	1,035.00	1,045.00	85.00	22.00	28.00	20.00
21st May -	44.25	83.00	1,005.00	1,015.00	85.00	21.50	28.00	20.00
28th May -	43.50	82.00	990.00	1,000.00	85.00	21.00	28.00	20.00
4th June -	41.50	79.00	980.00	990.00	85.00	20.25	27.00	19.00
11th June -	40.00	76.00	990.00	1,000.00	85.00	19.00	26.00	19.00
18th June -	39.50	74.00	1,010.00	1,020.00	85.00	19.00	26.00	19.00
25th June -	39.50	74.00	1,050.00	1,060.00	85.00	19.00	26.00	20.00

* F.O.B.

The above prices are taken from the weekly reports of the Singapore Chamber of Commerce.

FEDERATION OF MALAYA
PRODUCTION OF PALM OIL AND KERNELS.

(In long tons as declared by Estates)

Month	Palm Oil		Palm Kernels	
	1950	1951	1950	1951
January	3,959	4,068	896	1,178
February	3,643	3,510	970	970
March	4,861	3,821	1,184	1,196
April	4,918	3,732	1,249	1,083
May	4,433	4,260	1,086	1,258
June	4,226	3,295	1,070	968
July	4,361	3,249	1,070	901
August	4,586		1,193	
September	4,085		1,095	
October	4,859		1,234	
November	4,697		1,168	
December	4,543		1,227	
Total	53,171	(25,935)	13,442	(7,554)

In July, 46 estates (planted area 93,692 acres) were in production out of a total of 52 oil palm estates (planted area 96,643 acres).

MALAYAN AGRICULTURAL EXPORTS, JANUARY-MARCH, 1951.

Product	Net Exports in Tons.			
	Year 1949	Year 1950	Jan.-Mar., 1950	Jan.-Mar., 1951
Arecanuts	5,607	14,867	7,616	5,768
Coconuts, fresh † ‡	21,971 †	36,917 †	13,643 †	8,765 †
Coconut oil ‡	60,504	56,045	14,106	11,351
Copra ‡	24,424 *	4,778	1,720 *	38
Copra cake	27,643 *	31,105 *	8,095 *	9,375 *
Gambier, all kinds	293	331	183	25
Palm Kernels	8,744	9,070	2,293	2,793
Palm Oil	55,211	50,638	14,171	13,758
Pineapples, canned	8,130	14,666	3,829	3,519
Rubber ¶	670,257 ¶	692,585 ¶	161,572 ¶	163,648 ¶
Sago,—flour	1,476	12,006	1,590	5,949
„ —pearl	3,477	1,665	310	777
„ —raw	1,317 *	15,693 *	659 *	7,462 *
Tapioca,—flake	737	1,098	174	304
„ —flour	278 *	2,782 *	728 *	1,572 *
„ —pearl	12,345	13,507	3,456	2,269
Derris	48	44	17	21
‡ Copra equivalent	74,334	96,589	21,475	18,642

¶ production (Federation of Malaya). † hundreds in number. * net imports.

FEDERATION OF MALAYA RUBBER PRODUCTION.

(In long tons, dry weight)

Month	Estates		Smallholdings (Estimated)		Total	
	1950	1951	1950	1951	1950	1951
January	35,237	29,482	26,618	26,588	61,855	56,070
February	27,297	26,519	22,797	22,468	50,094	48,987
March	27,789	30,591	21,834	28,000	49,623	58,591
April	26,667	24,470	21,376	22,005	48,043	46,475
May	30,870	24,227	24,334	20,124	55,204	44,351
June	31,196	28,141	23,296	24,498	54,492	52,639
July	34,547	27,286	30,348	21,679	64,895	48,965
August	33,316		27,104		60,420	
September	30,323		26,643		56,966	
October	32,256		30,414		62,670	
November	30,138		28,476		58,614	
December	36,217		33,492		69,709	
Total	375,853	(190,716)	316,732	(165,362)	692,585	(356,078)
Total 1949	400,009		270,248		670,257	

This Table has been compiled from statistics published by the Registrar of Statistics, Federation of Malaya.

Smallholding production is estimated from purchases reported by dealers.

FEDERATION OF MALAYA
PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE.

(in tons)

Month	Copra Production						Coconut Oil Production		Copra Cake (Poonac) Manufactured	
	Estates		Smallholdings (estimated)		Total		Oil Mills		Oil Mills	
	1950	1951	1950	1951	1950	1951	1950	1951	1950	1951
January	2,577	2,346	7,765	8,501	10,342	10,847	5,501	5,537	3,634	3,532
February	2,662	2,516	6,868	6,323	9,530	8,839	4,831	4,856	3,182	3,072
March	3,064	3,059	7,062	9,078	10,126	12,137	5,774	5,796	3,798	3,784
April	3,002	2,888	7,367	7,832	10,369	10,720	4,847	5,742	3,201	3,585
May	3,424	3,200	10,160	10,764	13,584	13,964	6,507	6,718	4,341	4,342
June	3,761	3,692	9,109	9,518	12,870	13,210	6,373	7,287	4,176	4,716
July	3,767	4,083	9,158	11,580	12,925	15,663	5,962	8,571	3,938	5,567
August	3,580		9,916		13,496		6,315		4,222	
September	3,581		12,593		16,174		6,503		4,168	
October	3,390		11,567		14,957		7,320		4,805	
November	2,807		10,239		13,046		6,312		4,101	
December	2,997		9,062		12,059		6,555		4,253	
Total	38,612	(21,784)	110,866	(63,596)	149,478	(85,380)	72,800	(44,507)	47,819	(28,598)

Notes:—1. The above statistics are compiled and published by the Registrar of Statistics, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

METEOROLOGICAL SUMMARY, MALAYA, APRIL, 1951.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day	Number of days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										ins.	mm.	ins.						hrs.	hrs.	
Ipoh, Perak	93.0	73.5	83.3	96	71	88	77			7.95	201.9	1.77	17	15	7		1	216.20	7.21	
Port Swettenham, Selangor	89.4	72.8	81.1	93	71	78	75	85.7	85.4	5.87	149.1	1.05	18			1		186.01	6.20	
Kuala Lumpur, Selangor	91.0	74.1	82.5	94	72	83	77			12.91	327.9	1.71	19	17	14	7				
Sitiawan, Perak	90.5	73.5	82.0	93	71	85	76	85.7	85.9	8.01	203.5	3.30	16	12	6	2		214.51	7.15	
Kuala Lipis, Pahang	90.9	72.2	81.5	95	69	85	75	85.1	84.8	6.29	159.8	1.28	18	18	3	22		202.60	6.75	
Kuantan, Pahang	90.8	72.2	81.5	94	69	86	76			13.18	334.8	3.39	18	14	4	7		217.45	7.25	
Temerloh, Pahang	91.0	72.7	81.8	92	70	81	75			11.93	303.0	3.34	13	13	2	2		208.80	6.96	
Bayan Lepas, Penang	89.0	75.2	82.1	93	72	86	78			9.89	251.2	2.62	13	12	9			229.69	7.66	
Malacca	87.8	74.4	81.1	93	71	83	77			3.74	95.0	1.18	9					232.60	7.75	
Mersing, Johore	87.9	73.3	80.6	90	71	83	79			2.06	5.23	0.41	10	8	2			243.85	8.13	
Alor Star, Kedah	91.6	73.6	82.6	96	70	84	77			6.69	169.9	1.39	14	11	2			230.47	7.68	
Kota Bharu, Kelantan	89.3	74.5	81.9	92	71	86	77	88.7		2.74	69.6	1.48	10	8	2			255.90	8.53	
K. Trengganu, Trengganu	89.8	73.2	81.5	92	71	85	75			3.14	79.8	2.31	9	7	2	2		257.05	8.57	
Kallang Aerodrome (S'pore)	88.3	75.7	82.0	93	72	85	78			8.91	226.3	3.92	13	9	4			215.30	7.18	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	75.2	63.0	69.1	77	60	70	64	72.6	72.3	12.17	309.1	2.57	18		2	12		151.91	5.06	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	74.6	57.1	65.9	80	49	68	63	69.1	69.4	10.75	273.1	1.55	20	20	1	2		158.50	5.28	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, MAY, 1951.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										ins.	mm.	ins.						hrs.	hrs.	
Ipoh, Perak	91.2	73.2	82.2	96	71	83	75			15.15	384.8	4.02	19	16	9		1	181.55	5.86	
Port Swettenham, Selangor	90.1	73.4	81.7	94	71	85	76	85.5	85.7	9.64	244.9	3.00	22	19	1			196.71	6.35	
Kuala Lumpur, Selangor	90.5	74.1	82.3	94	72	84	76			6.54	166.1	1.28	18	14	8	4				
Sitiawan, Perak	88.9	73.5	81.2	93	72	82	76	85.1	86.0	4.95	125.7	1.06	18	18	9			181.52	5.85	
Kuala Lipis, Pahang	90.1	72.5	81.3	93	70	88	75	84.9	84.9	5.54	140.7	1.39	19	19	8	29		183.85	5.93	
Kuantan, Pahang	90.0	72.5	81.3	92	69	85	76			9.97	253.2	4.49	15	13	5	6		195.70	6.31	
Temerloh, Pahang	90.8	72.8	81.8	93	71	86	75			3.37	85.6	0.68	14	12	4	1		185.05	5.97	
Bayan Lepas, Penang	87.1	75.5	81.3	90	73	81	77			15.53	394.5	4.16	22	20	5			184.23	5.94	
Malacca	86.5	74.9	80.7	89	70	83	78			6.36	161.5	1.80	16					205.40	6.63	
Mersing, Johore	88.9	73.0	80.9	94	69	82	75			5.21	132.3	2.60	14	11	4			212.70	6.86	
Alor Star, Kedah	88.2	74.3	81.3	92	71	82	76			6.45	163.8	1.18	19	17	1			210.33	6.78	
Kota Bharu, Kelantan	89.5	74.5	82.0	93	72	88	77	86.7		9.75	247.7	3.99	15	13	10			249.75	8.06	
K. Trengganu, Trengganu	89.3	73.4	81.3	92	71	87	76			7.01	178.1	2.53	12	10	8			258.95	8.35	
Kallang Aerodrome (S'pore)	87.3	76.0	81.7	90	72	84	80			2.58	65.5	0.40	17	15	5		1	191.50	6.18	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	75.0	63.0	69.0	78	61	71	65	72.0	72.6	9.15	232.4	2.40	22		4	5		153.54	4.95	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.7	58.4	65.5	78	54	68	63	68.1	69.1	6.78	172.2	1.22	26	22				113.25	3.65	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JUNE, 1951.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day	Number of days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										ins.	mm.	ins.						hrs.	hrs.	
Ipoh, Perak	93.7	72.3	83.0	97	68	91	77			5.40	137.2	2.64	7	7	2		1	234.20	7.81	
Port Swettenham, Selangor	91.3	71.2	81.3	93	67	87	75	85.3	85.7	4.61	117.1	1.72	4	4				240.99	8.03	
Kuala Lumpur, Selangor	91.9	72.5	82.2	94	69	88	76			3.14	79.8	1.39	6	6	3	3				
Sitiawan, Perak	90.9	72.3	81.6	93	69	88	77	85.6	86.1	0.95	24.1	0.46	3	3				233.98	7.80	
Kuala Lipis, Pahang	90.8	71.9	81.3	94	69	87	75	85.1	85.1	2.03	51.6	0.58	7	7	3	28		206.45	6.88	
Kuantan, Pahang	90.9	72.2	81.5	95	67	81	76			2.48	63.0	1.26	7	7		4		194.95	6.50	
Temerloh, Pahang	91.3	71.6	81.5	94	69	81	74			3.87	98.3	2.55	6	6	2	6		212.90	7.10	
Bayan Lepas, Penang	89.1	75.0	82.1	92	72	85	79			3.47	88.1	1.78	7	7				229.76	7.66	
Malacca	88.0	73.6	80.8	91	70	85	77			3.83	97.3	1.67	5	5	1		1	246.60	8.22	
Mersing, Johore	89.1	73.0	81.1	92	70	85	77			3.40	86.4	1.99	6	4	2			250.90	8.36	
Alor Star, Kedah	90.3	74.2	82.3	94	71	83	77			3.64	82.5	2.38	8	7			1	207.95	6.93	
Kota Bharu, Kelantan	90.3	75.1	82.7	93	73	86	78	88.4		1.90	48.3	0.92	9	6	4			229.60	7.65	
K. Trengganu, Trengganu	90.8	73.8	82.3	94	71	83	75			0.45	11.4	0.25	5	3	2	2		243.55	8.12	
Kallang Aerodrome (S'pore)	88.8	77.2	83.0	91	72	82	82			3.21	81.5	1.49	5	4	2		1	232.05	7.73	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	75.6	62.5	69.1	79	59	72	64	72.8	72.9	3.08	78.2	1.44	11			7		197.15	6.57	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	75.3	55.7	65.5	80	48	72	64	68.5	69.8	3.48	88.4	1.47	13	12	1			190.55	6.35	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JULY, 1951.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day	Number of days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										ins.	m.m.	ins.						hr.	hr.	
Ipoh, Perak	90.6	72.0	81.3	96	69	82	74			3.77	95.8	0.85	19	17	3			192.90	6.22	
Port Swettenham, Selangor	89.0	71.7	80.3	93	69	82	74	84.3	85.8	6.16	156.5	1.86	14	12				200.12	6.45	
Kuala Lumpur, Selangor	89.2	72.3	80.7	93	71	83	75			5.61	142.5	2.22	15	14	1	3				
Sitiawan, Perak	89.1	72.6	80.9	93	69	81	74	84.5	85.9	5.87	149.1	1.55	13	11	1			202.90	6.55	
Kuala Lipis, Pahang	90.3	71.6	80.9	94	70	86	74	84.5	85.1	5.43	137.9	1.87	11	11	3	25		182.65	5.89	
Kuantan, Pahang	90.0	71.0	80.5	93	68	86	75			2.70	68.6	1.20	11	11	2	3		201.15	6.49	
Temerloh, Pahang	90.6	71.3	80.9	94	69	85	74			6.81	173.0	1.74	14	14	2	3		207.95	6.71	
Bayan Lepas, Penang	86.7	73.9	80.3	91	71	78	77			14.97	380.2	4.09	20	15	3			191.26	6.17	
Malacca	86.0	73.7	79.9	88	72	82	76			10.07	255.8	3.68	16	13	2		4	217.40	7.01	
Mersing, Johore	87.3	71.8	79.5	90	70	85	75			6.32	160.5	1.21	13	11	4		1	194.65	6.28	
Alor Star, Kedah	87.7	73.3	80.5	93	71	77	77			9.60	243.8	3.29	19	17	2		1	187.55	6.05	
Kota Bharu, Kelantan	88.2	73.5	80.9	92	71	81	76	85.9		4.43	112.5	1.08	11	11	8			214.85	6.93	
K. Trengganu, Trengganu	88.7	72.3	80.5	92	70	80	74			4.44	112.8	1.75	12	10	8			234.25	7.56	
Kallang Aerodrome (S'pore)	86.4	75.5	80.9	90	72	82	80			10.64	270.3	3.30	15	11	9		1	177.80	5.73	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	73.6	61.9	67.7	77	60	70	64	72.0	72.3	8.60	218.4	1.58	17	16	1	7		163.65	5.28	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.9	56.0	64.5	79	49	65	62	67.5	69.4	6.77	172.0	1.16	19	18				156.20	5.04	

Compiled from Returns supplied by the Malayan Meteorological Service.